Apple Creek Nonpoint Source Watershed Implementation Plan



Prepared by:

Outagamie County Land Conservation Department

2017

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Acknowledgements

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A special acknowledgement and thank you to all the landowners that participated in the Alliance for the Great Lakes Survey and the local agronomists and consultants who helped administer the survey.

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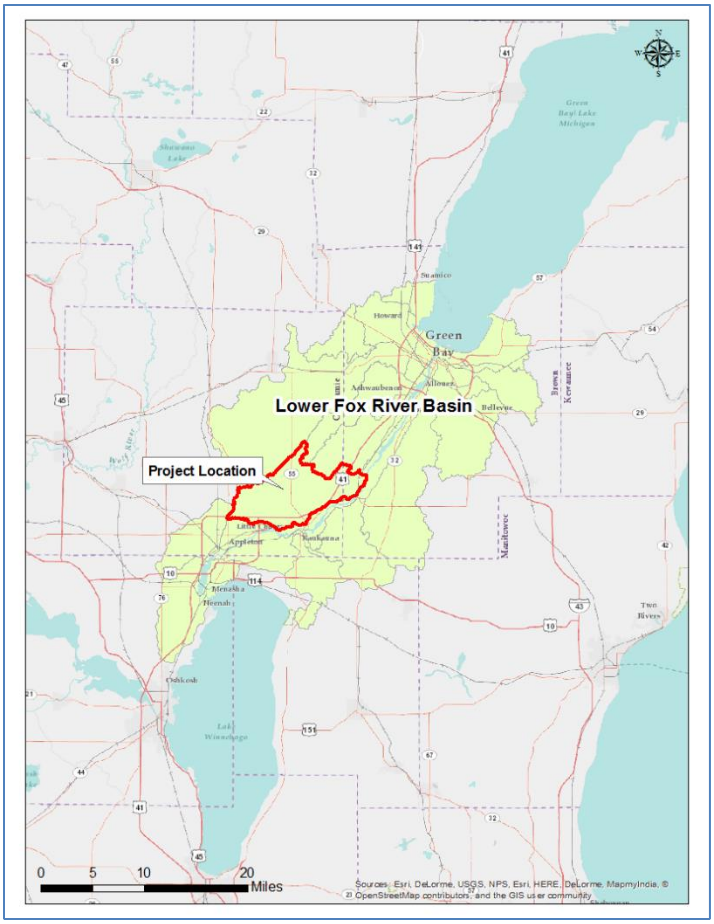
Apple Creek Watershed Implementation Plan

Executive Summary

The Apple Creek Watershed is a subwatershed of the Lower Fox River Basin and is located in east central Wisconsin in Outagamie and Brown Counties. Apple Creek empties into the Fox River near Wrightstown, WI, draining approximately 33,190 acres.



Historically, the land in this area was forested with many wetlands. It is estimated that wetlands encompassed 20% of the land pre-settlement. The Lower Fox River Basin was home to many Native American cultures before Europeans began to settle in the area in the early 1800's. The farming and paper industry in the area has led to clearing of forests and natural areas and draining of wetlands in the Lower Fox River Basin. Farming, industry, and urban development in the Lower Fox River Basin has led to poor water quality in the Fox River and Bay of Green Bay.

Excessive sediment loads and increased algal blooms in the Lower Fox River and Bay of Green Bay prompted the need for action to be taken in the Lower Fox River Basin. A Total Maximum Daily Load was approved for the Lower Fox River and Lower Green Bay and its tributaries in 2012. The development of implementation plans for the subwatersheds of the Lower Fox River Basin are necessary to meet the assigned daily loads of the TMDL.

Lower Fox River Basin Total Maximum Daily Load Allowances and Reductions for Apple Creek Watershed

Loading Summary	Total Phosphorus (lbs/yr)	Total Suspended Solids (tons/yr)
Baseline	35,088	6,368
TMDL	12,557	3,106
Reduction	22,531	3,262
% Reduction Needed	64.2	51.2

<u>The Apple Creek Watershed plan provides a framework to accomplish the following goals:</u>

Goal #1: Improve surface water quality to meet the TMDL limits for total phosphorus and sediment.

Goal #2: Increase citizens' awareness of water quality issues and active participation in stewardship of the watershed.

Goal #3: Reduce runoff volume and flood levels during peak storm events.

Goal #4: Improve streambank stability and reduce amount of streambank degradation.

<u>Challenges and sources in the watershed:</u>


Streambank erosion occurring on Apple Creek (Summer 2016)

The dominant land use in the watershed is agriculture and is responsible for approximately 55.2% of the sediment and 78.2% of the phosphorus loading in the watershed. Wetlands and natural areas have been cleared and drained to increase agricultural production in this area. Recent high land values and rental rates due to competition with urban development and farm expansion in this watershed have exacerbated the amount of natural areas lost. A predominant focus on maximum production of all available acreage combined with a lack of awareness of the need for conservation practices and sustainable management of farmland in this area has led to significant sediment and nutrient loss from agricultural land.

Increased drainage and flooding has led to significant erosion of streambanks during high flow periods. Moderate to very severe streambank erosion was found to be occurring along the majority of main stream channels on Apple Creek. Sediment loading estimates based on field inventory of streambank erosion was significantly higher than what was predicted by TMDL watershed modeling.

Approximately 36 % of the land in the watershed is urban which also contributes to a substantial amount of nutrient and phosphorus loading to Apple Creek. The amount of urban area in the Apple Creek watershed is predicted to continually increase. If local construction and post construction ordinances required by municipal MS4 permits are not enforced, this could contribute to an increase in nutrient and phosphorus loading to Apple Creek.

Watershed Implementation Plan:

In order to meet the goals for the watershed a 10 year implementation plan was developed. The action plan recommends best management practices, information and education activities, and needed restoration to achieve the goals of the watershed project. The plan includes estimated cost, potential funding sources, agencies responsible for implementation, and measures of success.

Recommended Management Practices:

- Reduced Tillage Methods (Strip/Zone till, No till, Mulch till)
- Cover Crops
- Vegetated Buffers
- Wetland Restoration
- Grassed/Lined Waterways
- Nutrient Management
- Low Disturbance Manure Injection and/or other alternative manure management practices
- Streambank Restoration
- Water and Sediment Control Basins/Grade Stabilization
- Critical Area Planting
- Exploring new technologies/practices (soil amendments, tile drainage water management, phosphorus removal structures, etc.)

Education and Information Recommendations:

- Provide educational workshops and tours on how to implement best management practices.
- Engage landowners in planning and implementing conservation on their land and by providing information on the technical tools and financial support available to them.
- Provide information on water quality and conservation practices to landowners in the watershed area.

- Newsletters and/or webpage with watershed project updates and other pertinent conservation related information.

Women Caring for the Land Workshop in Outagamie County 9/10/2015

Conclusion

Meeting the goals for the Apple Creek watershed will be challenging. Watershed planning and implementation is primarily a voluntary effort with limited enforcement for "non-compliant" sites that will need to be supported by focused technical and financial assistance. It will require widespread cooperation and commitment of the watershed community to improve the water quality and condition of the watershed. This plan needs to be adaptable to the many challenges, changes and lessons that will be found in this watershed area as implementation moves forward.

List of Acronyms

AM- Adaptive Management

BMP- Best Management Practice

CAFO- Concentrated Animal Feeding Operation

CLU- Common Land Unit

GBMSD- Green Bay Metropolitan Sewerage District (NEW Water)

GLRI- Great Lakes Restoration Initiative

GIS- Geographic Information System

HSG-Hydrologic Soil Group

IBI- Index of Biotic Integrity

LFRWMP- Lower Fox River Watershed Monitoring Program

LWCD/LCD- Land and Water Conservation Department/ Land Conservation Department

MDV- Multi- Discharger Variance

MS4- Municipal Separate Storm Sewer System

NRCS-Natural Resource Conservation Service

PI- Phosphorus Index

USEPA- United States Environmental Protection Agency

UWEX- University of Wisconsin Extension

USDA- United States Department of Agriculture

USGS-United States Geologic Service

UWGB-University of Wisconsin-Green Bay

WDNR-Wisconsin Department of Natural Resources

WPDES- Wisconsin Pollutant Discharge Elimination System

WWTF- Waste Water Treatment Facility

TMDL-Total Maximum Daily Load

TP- Total Phosphorus

TSS- Total Suspended Solids

WQT- Water Quality Trading

WLA-Waste Load Allocation

***Note*: Lower Fox River TMDL plan-** Refers to the report "*Total Maximum Daily Load and Watershed Management Plan for Total Phosphorus and Total Suspended Solids in the Lower Fox River Basin and Lower Green Bay"* prepared by the Cadmus Group that was approved in 2012 by WDNR and EPA.

1.0 Introduction

1.1 Apple Creek Watershed Setting

The Apple Creek Watershed is a sub watershed of the Lower Fox River Basin in Wisconsin located in Outagamie County and Brown County. The watershed drains a total area of 33,190 acres and is located North of Lake Winnebago and Southwest of the Bay of Green Bay. Apple Creek empties into the Fox River near Wrightstown, Wisconsin. The watershed is predominately agricultural land and includes portions of the Towns of Lawrence, Freedom, Grand Chute, Center, Vandenbroek, Wrightstown, Kaukauna as well as the Village of Little Chute, City of Appleton, and City of Kaukauna.

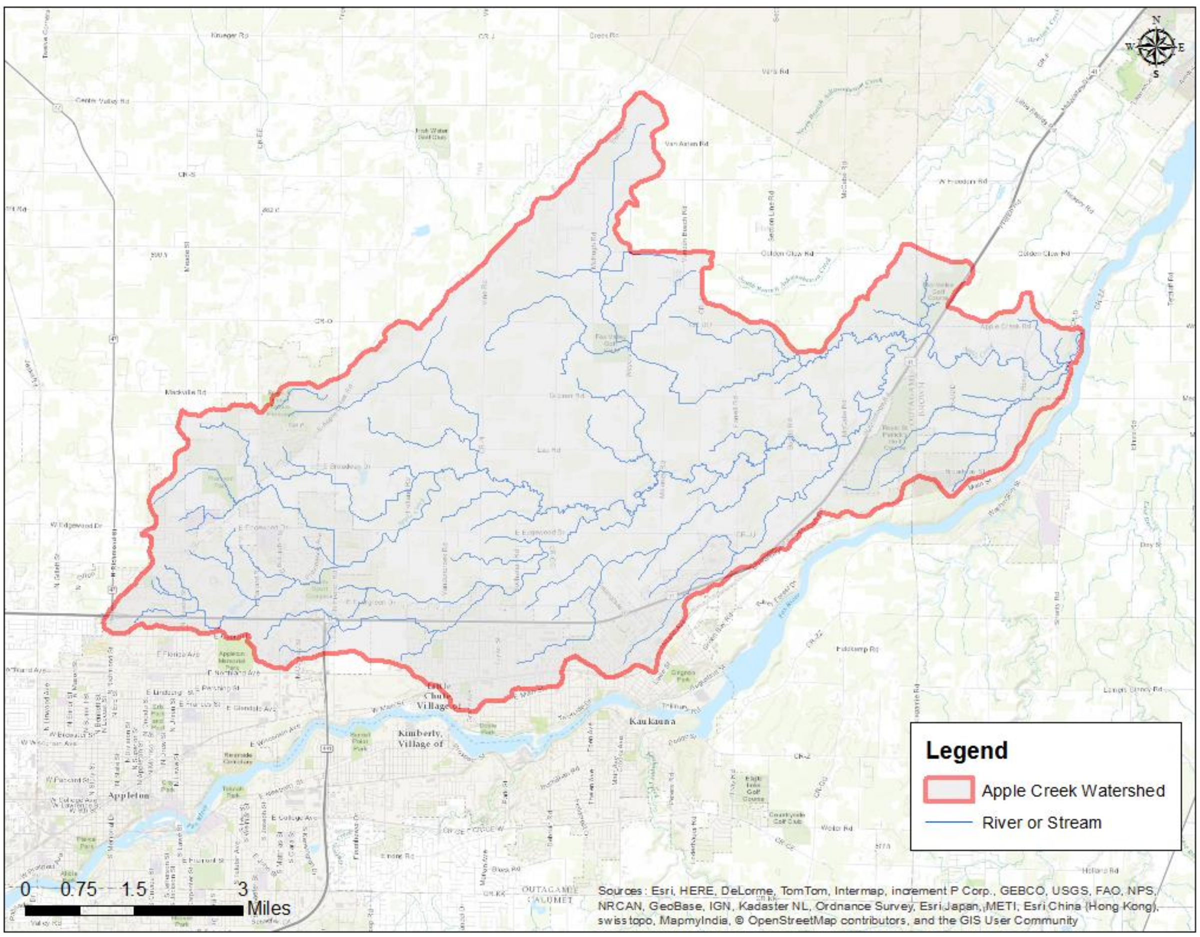


Figure 1. Apple Creek Watershed.

1.2 Purpose

Excessive sediment and nutrient loading to the Lower Fox River and Bay of Green Bay has led to increased algal blooms, oxygen depletion, water clarity issues, and degraded habitat. Algal blooms can be toxic to humans and costly to a local economy. Estimated annual economic losses due to eutrophication in the United States are as follows: recreation ($1 billion), waterfront property value ($0.3-2.8 million), recovery of threatened and endangered species ($44 million) and drinking water ($813 million) (Dodds, et al 2009). Due to the impairments of the Lower Fox River Basin, a TMDL (Total Maximum Daily Load) was developed for the Lower Fox River basin and its tributaries that was approved in 2012. The purpose of this project is to develop an implementation plan for the Apple Creek subwatershed to meet the requirements of the TMDL. The Lower Fox River TMDL requires that any tributaries to the Lower Fox River meet a median summer total phosphorus limit of 0.075 mg/l or less. A median total suspended solids limit has not been determined for tributaries but is set at 18 mg/l for the outlet of the Fox River.

Figure 2. Mouth of the Fox River emptying into the Bay of Green Bay, April 2011. Photo Credit: Steve Seilo.

1.3 US EPA Watershed Plan Requirements

In 1987, Congress enacted the Section 319 of the Clean Water Act which established a national program to control nonpoint sources of water pollution. Section 319 grant funding is available to states, tribes, and territories for the restoration of impaired waters and to protect unimpaired/high quality waters. Watershed plans funded by Clean Water Act section 319 funds must address nine key elements that the EPA has identified as critical for achieving improvements in water quality (USEPA 2008). The nine elements from the USEPA Nonpoint Source Program and Grants Guidelines for States and Territories are as follows:

1. Identification of causes of impairment and pollutant sources or groups of similar sources that need to be controlled to achieve needed load reductions, and any other goals identified in the watershed plan. Sources that need to be controlled should be identified at the significant subcategory level along with estimates of the extent to which they are present in the watershed

2. An estimate of the load reductions expected from management measures.

3. A description of the nonpoint source management measures that will need to be implemented to achieve load reductions in element 2, and a description of the critical areas in which those measures will be needed to implement this plan.

4. Estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon to implement this plan.

5. An information and education component used to enhance public understanding of the plan and encourage their early and continued participation in selecting, designing, and implementing the nonpoint source management measures that will be implemented.

6. Schedule for implementing the nonpoint source management measures identified in this plan that is reasonably expeditious.

7. A description of interim measurable milestones for determining whether nonpoint source management measures or other control actions are being implemented.

8. A set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made toward attaining water quality standards.

9. A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established under element 8.

1.4 Prior Studies, Projects, and Existing Resource Management and Comprehensive Plans

Various studies have been completed in the Lower Fox River Basin and Lake Michigan Basin describing and analyzing conditions in the area. Management and Comprehensive plans as well as monitoring programs have already been developed for the Lower Fox River Basin and Lake Michigan Basin. A list of known studies, plans, and monitoring programs are listed below:

Total Maximum Daily Load & Watershed Plan for Total Phosphorus and Total Suspended Solids in the Lower Fox River Basin and Lower Green Bay -2012

The *TMDL & Watershed Plan for Total Phosphorus and Total Suspended Solids in the Lower Fox River Basin and Lower Green Bay* was prepared by the Cadmus Group for the EPA and WDNR and was approved in 2012. This plan set a TMDL for the Lower Fox River and its tributaries as well as estimated current pollutant loading and loading reductions needed to meet the TMDL for each subwatershed in the Lower Fox River Basin.

Lower Fox River Watershed Monitoring Program

The Lower Fox River Watershed Monitoring Program is a watershed education and stream monitoring program that involves coordination from university students and researchers from University of Wisconsin-Green Bay, University of Wisconsin-Milwaukee, Green Bay Metropolitan Sewerage District (GBMSD/New Water), Cofrin Center for Biological Diversity, and the United States Geological Survey. The program also involves area high school teachers and students.

Lake Michigan Lakewide Management Plan-2008

Plan developed by the Lake Michigan Technical Committee with assistance from the Lake Michigan Forum and other agencies and organizations. The plan focuses on improving water quality and habitat in the Lake Michigan basin including reducing pollutant loads from its tributaries.

Lower Green Bay Remedial Action Plan-1993

The Lower Green Bay Remedial Action Plan is a long term strategy for restoring water quality to the Lower Green Bay and Fox River. Two of the top five priorities for the Remedial Action Plan are to reduce suspended sediments and phosphorus.

Hydrology, Phosphorus, and Suspended Solids in Five Agricultural Streams in the Lower Fox River and Green Bay Watersheds, Wisconsin, Water Years 2004-2006

A 3-year study done by the U.S. Geological Survey and University of Wisconsin-Green Bay to characterize water quality in agricultural streams in the Fox/Wolf watershed and provided information to assist in the calibration of a watershed model for the area.

Nonpoint Source Control Plan for the Duck, Apple, and Ashwaubenon Creeks Priority Watershed Project

Nonpoint watershed plan developed for the Duck, Apple, and Ashwaubenon Creeks Watersheds that focused on phosphorus and sediment reduction. The Wisconsin Nonpoint Source Water Pollution Abatement Program provided cost sharing to landowners who voluntarily implemented best management practices in priority watershed areas. Plan implementation began in 1995 and ended in 2010. A moratorium on signing agreements for non-structural practices was placed on September 5, 2001 which put the upland sediment goal of the plan out of reach. A final project report also concluded that the watershed would also benefit from more buffered areas between cropland and streams.

1.5 Wisconsin Ecoregion

Ecoregions are based on biotic and abiotic factors such as climate, geology, vegetation, wildlife, and hydrology. The mapping of ecoregions is beneficial in the management of ecosystems and has been derived from the work of James M. Omernik of the USGS. The Apple Creek watershed is located in the Southeastern Wisconsin Till Plains ecoregion and in the Lake Michigan Lacustrine clay sub ecoregion. The Southeastern Wisconsin Till Plains supports a variety of vegetation types from hardwood forests to tall grass prairies. Land used in this region is mostly used for cropland and has a higher plant hardiness value than in ecoregions to the north and west.

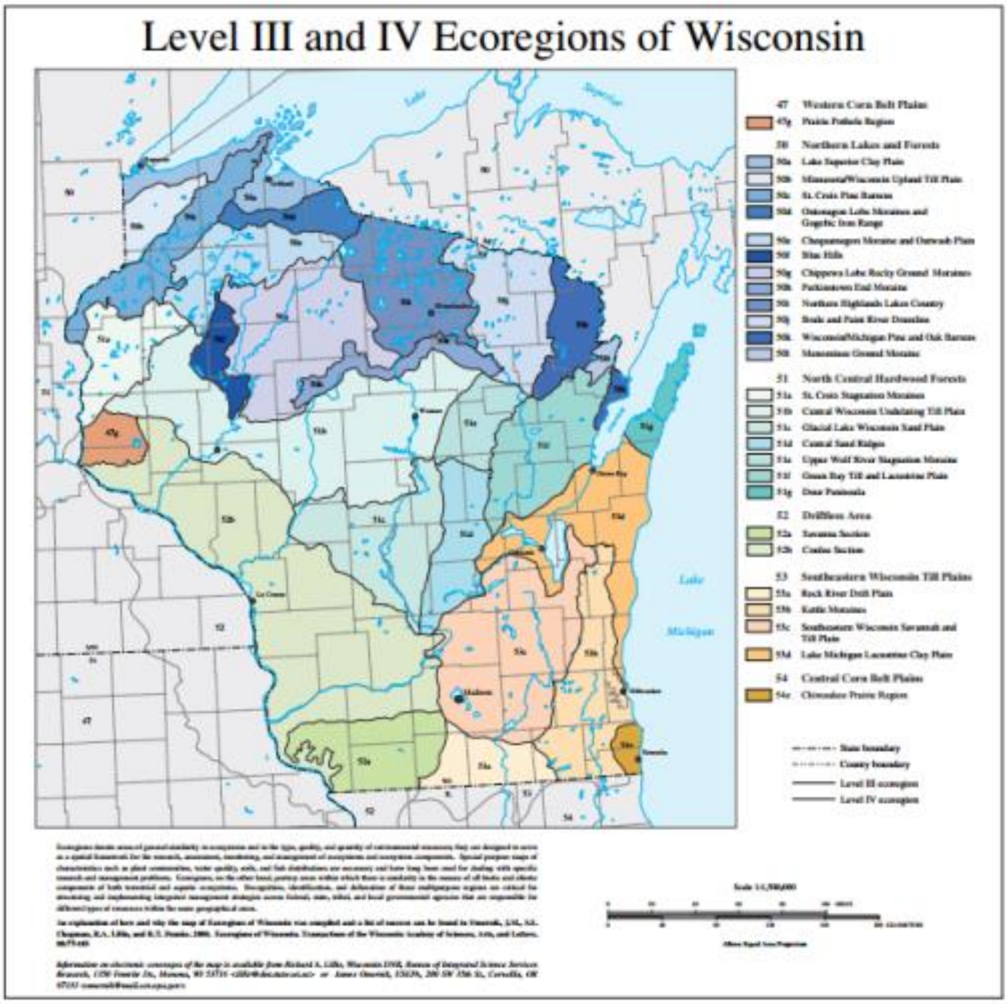


Figure 3. Map of Ecoregions of Wisconsin. Source: Omernik et al 2000.

1.6 Climate

Wisconsin has a continental climate that is affected by Lake Michigan and Lake Superior. Wisconsin typically has cold, snowy winters and warm summers. The average annual temperature ranges from 39^{o}F in the north to about 50^{o}F in the south. Temperatures can reach minus 30^{o}F or colder in the winter and above 90^{o}F in the summer. Average annual precipitation is about 30 inches a year in the watershed area. The climate in central and southern Wisconsin is favorable for dairy farming, where corn, small grains, hay, and vegetables are the primary crops.

1.7 Topology and geology

The Apple Creek watershed lies in the Eastern Ridges and Lowlands geographical province of Wisconsin. The Apple Creek watershed area was part of the glaciated portion of Wisconsin. During the last Ice Age the Laurentide Ice Sheet began to advance into Wisconsin where it expanded for 10,000 years before it began to melt back after another 6,500 years. Glaciers have greatly impacted the geology of the area. The topography is generally smooth and gently sloping with some slopes steepened by post glacial stream erosion. The main glacial landforms are ground moraine, outwash, and lake plain. The highest point in the watershed area is 917 ft above sea level in the Northwest portion of the watershed and the lowest point in the watershed is 557 feet above sea level in the Southeast corner (Figure 5). There is a 360 foot change in elevation from highest and lowest point in the watershed.

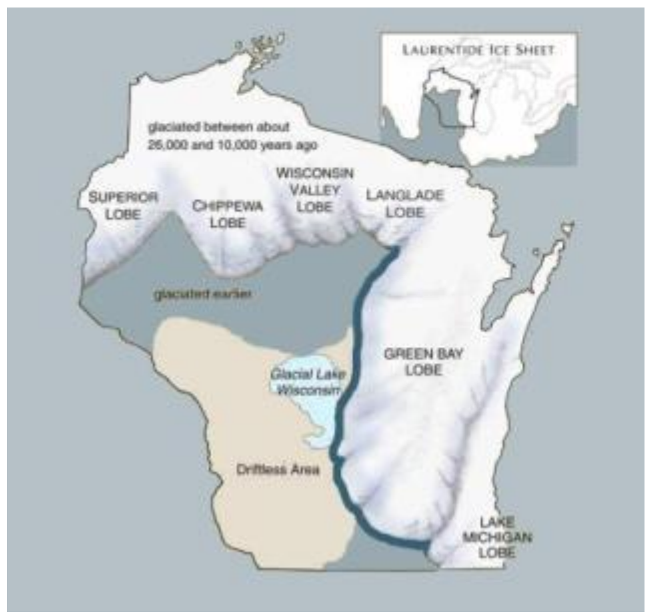


Figure 4. Ice Age Geology of Wisconsin.
©Mountain Press, 2004

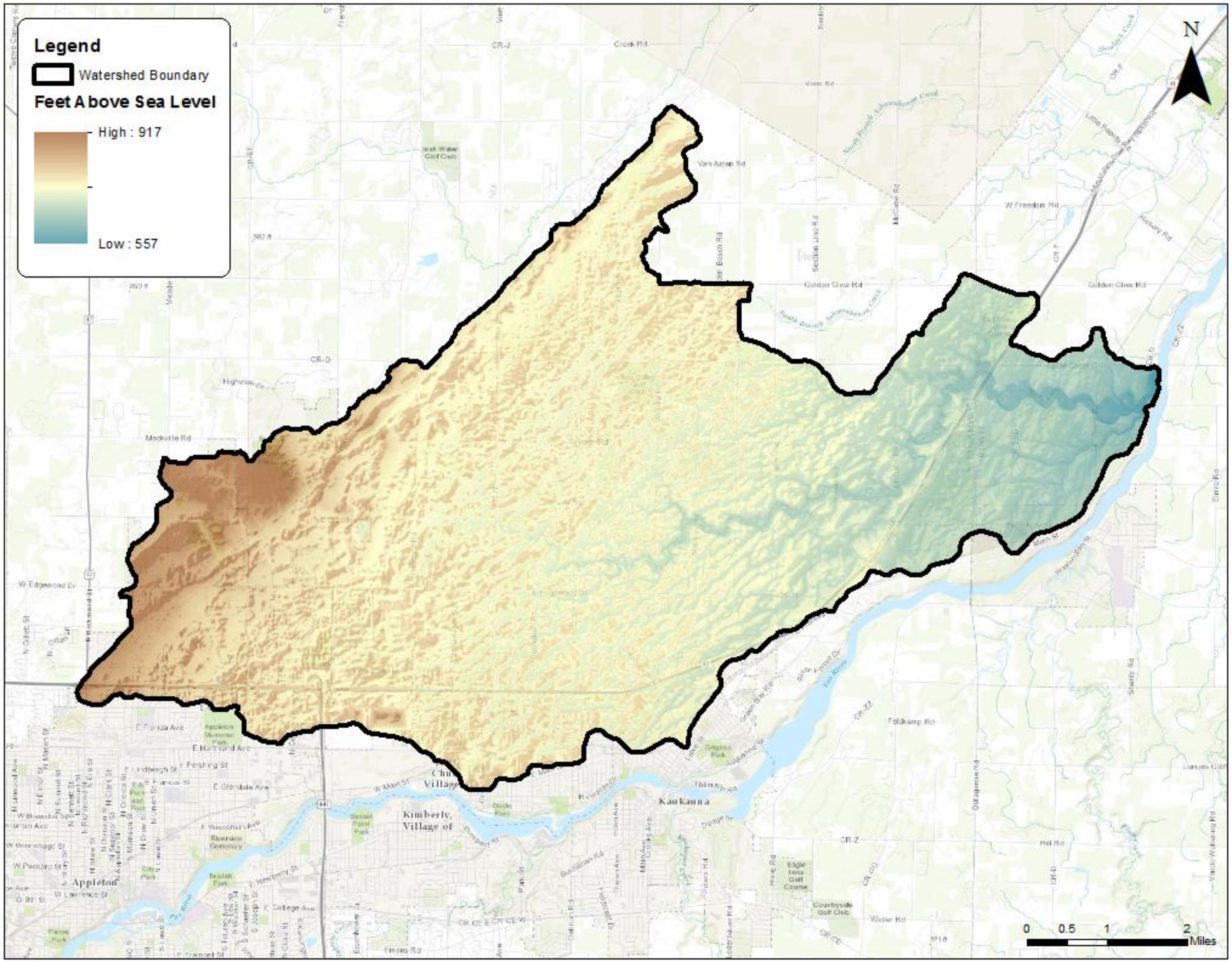


Figure 5. Digital Elevation Model

1.8 Soil Characteristics

Soil data for the watershed was obtained from the Natural Resources Conservation Service (SSURGO) database. The type of soil and its characteristics are important for planning management practices in a watershed. Factors such as erodibility, hydric group, slope, and hydric rating are important in estimating erosion and runoff in a watershed.

The dominant soil types in the watershed are Manawa silty clay loam (17.8%), Winneconne silty clay loam (22.5 %), Kewaunee silt loam (14%), Kewaunee-Manawa complex (6%), and Hortonville silt loam (3.8%).

Hydrologic Soil Group

Soils are classified into hydrologic soil groups based on soil infiltration and transmission rate (permeability). Hydrologic soil group along with land use, management practices, and hydrologic condition determine a soil's runoff curve number. Runoff curve numbers are used to estimate direct runoff from rainfall. There are four hydrologic soil groups: A, B, C, and D. Descriptions of Runoff Potential, Infiltration Rate, and Transmission rate of each group are shown in Table 1. Some soils fall into a dual hydrologic soil group (A/D, B/D, and C/D) based on their saturated hydraulic conductivity and water table depth when drained. The first letter applies to the drained condition and the second letter applies to the undrained condition. Table 2 summarizes the acreage and percent of each group present in the watershed and Figure 6 shows the location of each hydrologic soil group. The dominant hydrologic soil group in the watershed is Group D (61%). Group D soils have the highest runoff potential followed by group C. Soils with high runoff potentials account for 82.8% of the soils in the watershed.

Table 1. Hydrologic Soil Group Description.

HSG	Runoff Potential	Infiltration Rate	Transmission Rate
A	Low	High	High
B	Moderately Low	Moderate	Moderate
C	Moderately High	Low	Low
D	High	Very Low	Very Low

Table 2. Hydrologic Soil Group.

Hydrologic Soil Group	Acres	Percent
A	1,084	3
A/D	1,047	3
B	1,580	5
B/D	1,935	6
C	5,483	17
C/D	1,717	5
D	20,099	61
Not Classified	245	1
Total	**33,190**	**100**

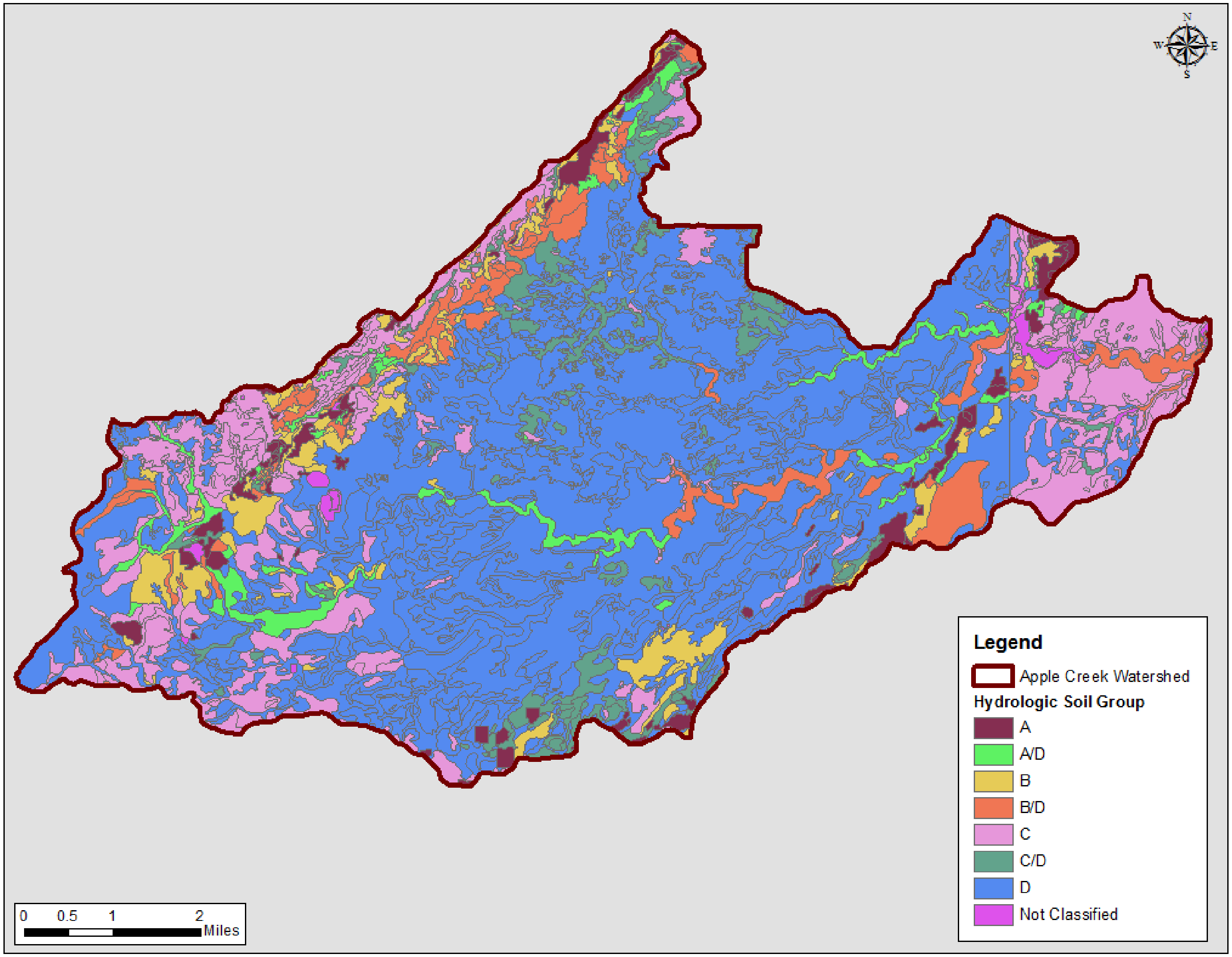


Figure 6. Hydrologic Soil Groups

Soil Erodibility

The susceptibility of a soil to wind and water erosion depends on soil type and slope. Course textured soils, such as sand, are more susceptible to erosion than fine textured soils such as clay. The soil erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. It is one of the six factors used in the Revised Universal Soil Loss Equation (RUSLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons/acre/year. Values of K range from 0.02 to 0.55. Soil erodibility factors for Apple Creek are shown in Figure 7, soils with high erodibility are indicated by orange and red.

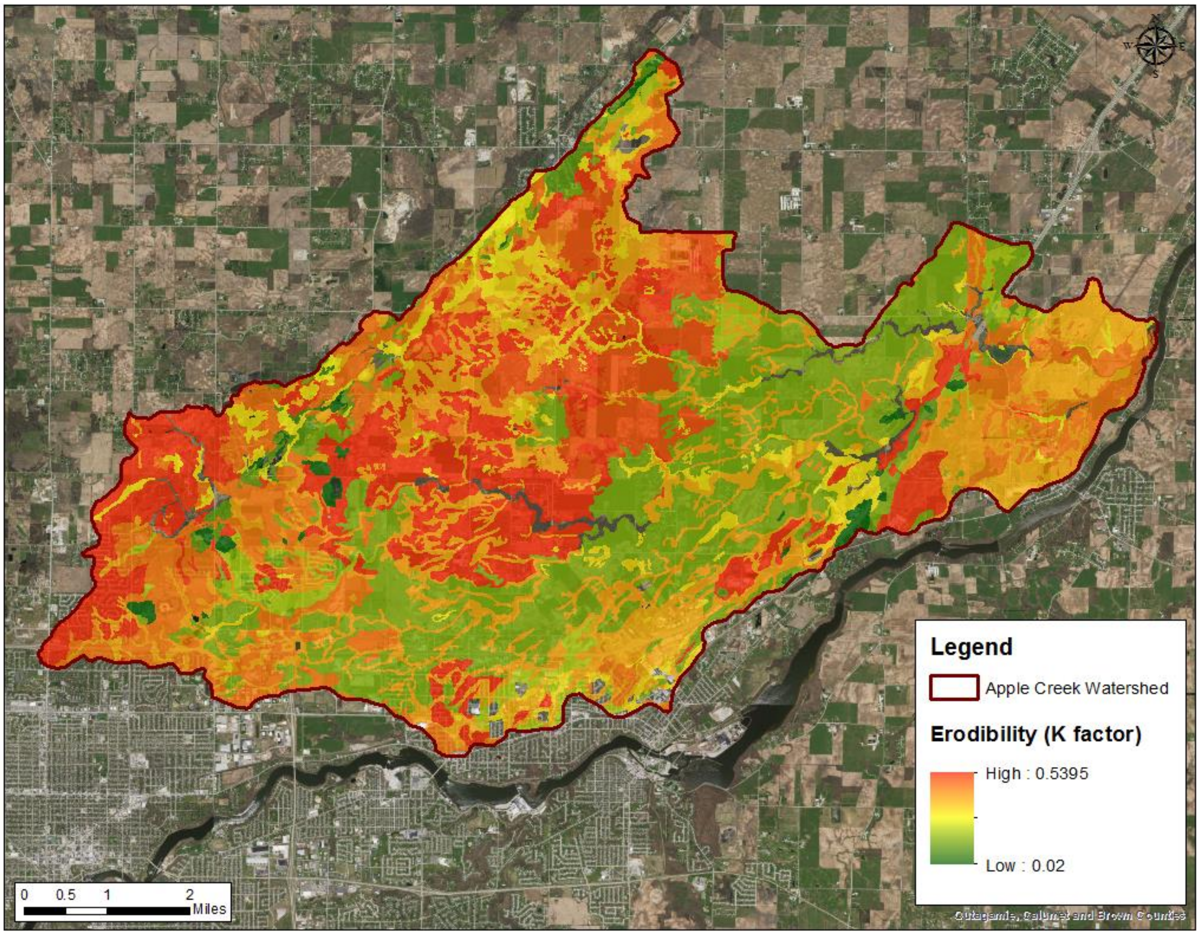


Figure 7. Soil erodibility.

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2.0 Watershed Jurisdictions, Demographics, and Transportation Network

2.1 Watershed Jurisdictions

The majority of Apple Creek Watershed is located in Outagamie County and a small portion resides in Brown County. The Town of Freedom, Town of Center, Town of Lawrence, Town Wrightstown, Town of Vandenbroek, Town of Wrightstown, Village of Wrightstown, Village of Little Chute, Town of Grand Chute, City of Kaukauna, and the City of Appleton are located in the watershed area (Figure 8).

Table 3. Watershed Jurisdictions.

Jurisdiction	Acres	Percent
County		
Brown County	2,995.00	9.0
Outagamie County	30,197.00	91.0
Municipality		
City of Appleton	4,199	12.7
City of Kaukauna	1,095	3.3
Town of Center	228	0.7
Town of Freedom	9,908	29.9
Town of Grand Chute	1,532	4.6
Town of Kaukauna	5,102	15.4
Town of Lawrence	540	1.6
Town of Vandenbroek	5,263	15.9
Town of Wrightstown	2,067	6.2
Village of Little Chute	2,220	6.7
Village of Wrightstown	1,618	4.9

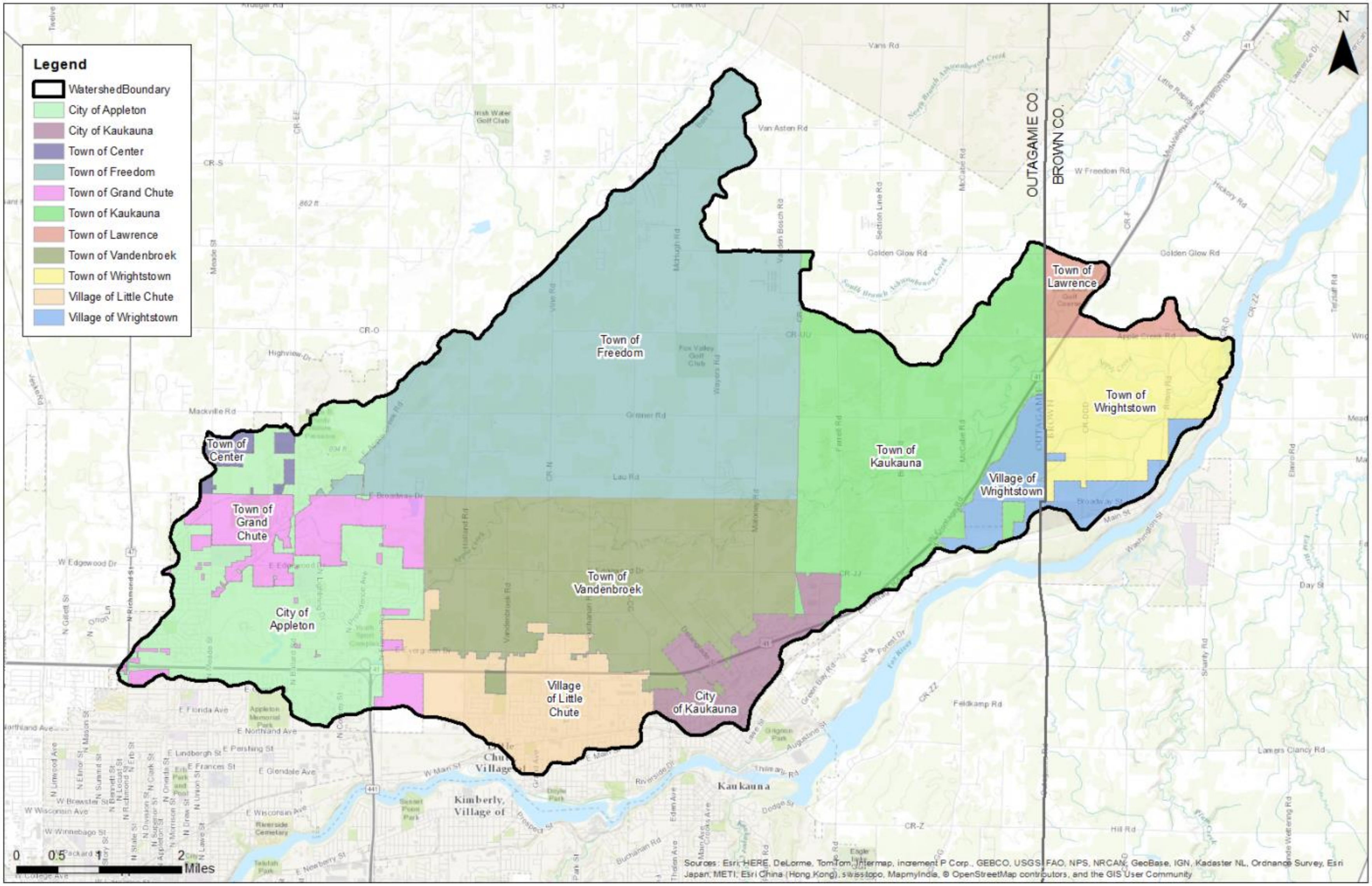

Figure 8. Apple Creek Watershed Jurisdictions.

2.2 Jurisdictional Roles and Responsibilities

Natural resources in the United States are protected to some extent under federal, state, and local law. The Clean Water Act is the strongest regulating tool at the national level. In Wisconsin, the Wisconsin Department of Natural Resources has the authority to administer the provisions of the Clean Water Act. The U.S. Fish and Wildlife Service and U.S. Army Corps of Engineers work with the WDNR to protect natural areas, wetlands, and threatened and endangered species. The Safe Drinking Water Act also protects surface and groundwater resources.

Counties and other local municipalities in the watershed area have already established ordinances regulating land development and protecting surface waters. All municipalities have ordinances relating to Shoreland and Wetland Zoning, Erosion Control, and Stormwater. Municipalities have to meet the minimum requirements of County ordinances, however, they have the ability to adopt higher levels of protection. In addition to urbanization-level regulations, Outagamie and Brown County have Animal Waste Management & Runoff management ordinances along with the implementation of the Working Lands Initiative program provide additional watershed protection above and beyond existing ordinances under local municipal codes.

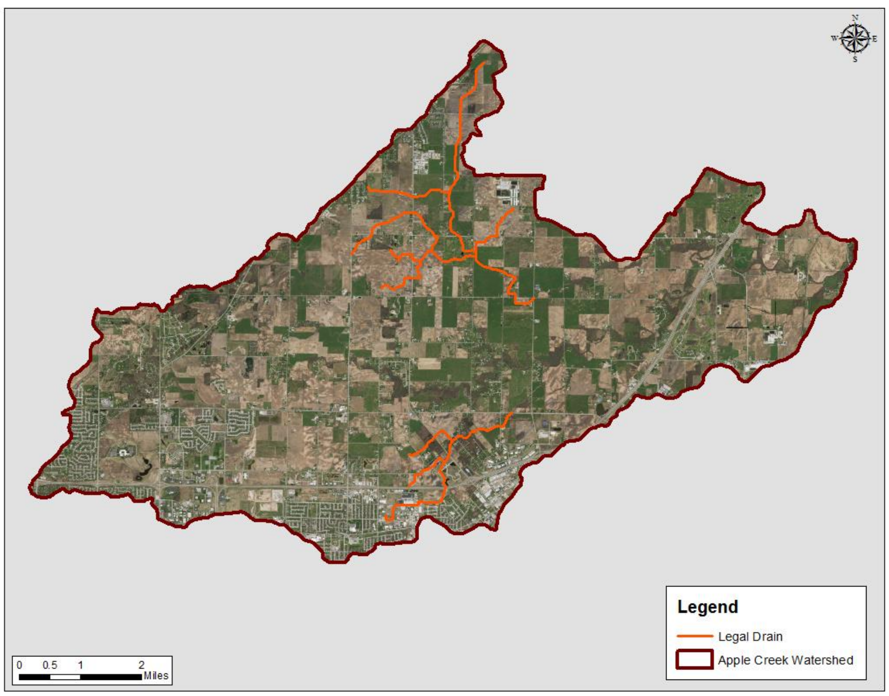

Figure 9. Apple Creek Legal Drains.

Part of the Apple Creek is in a legal drainage district and is under jurisdiction of the drainage board. A drainage district is a local governmental district which is organized to drain lands for agricultural or other purposes. Landowners who benefit from drainage must pay assessments to cover the cost of constructing, maintaining, and repairing the district drains. The county drainage board is required to ensure that all drainage districts under its jurisdiction comply with the standards in the drainage rule (Ch. ATCP 48, Wis. Admin Code) and statue (Ch. 88, Wis. Stats.).

The Northeast Wisconsin Stormwater Consortium (NEWSC) is a private entity in the watershed area that provides a technical advisory role to local municipalities and engineering consultants.

In 2002, Fox Wolf Watershed Alliance began exploring the creation of an organization to assist local and county governments in cooperative efforts to address storm water management, which led to the creation of NEWSC. Outagamie County, Brown County, City of Kaukauna, City of Appleton, Village of Little Chute, Town of Grand Chute, and Town of Lawrence have representatives in the organization. NEWSC facilitates efficient implementation of stormwater programs that meet DNR and EPA regulatory requirements and maximize the benefit of stormwater activities to the watershed by fostering partnerships, and by providing technical, administrative, and financial assistance to its members.

Other governmental and private entities with watershed jurisdictional or technical advisory roles include: Natural Resources Conservation Service, Department of Agriculture, Trade, and Consumer Protection, East Central Wisconsin Regional Planning Commission, and Department of Transportation.

2.3 Transportation

The major roads that run through the Apple Creek watershed include WI State HWY 55, County Highways N, J, E, CC and Interstate I-41(Figure 10). WI-55 runs north-south through the center of the watershed, and I-41 runs along the southern watershed boundary. The Canadian National Railway also runs along the southern border of the watershed.

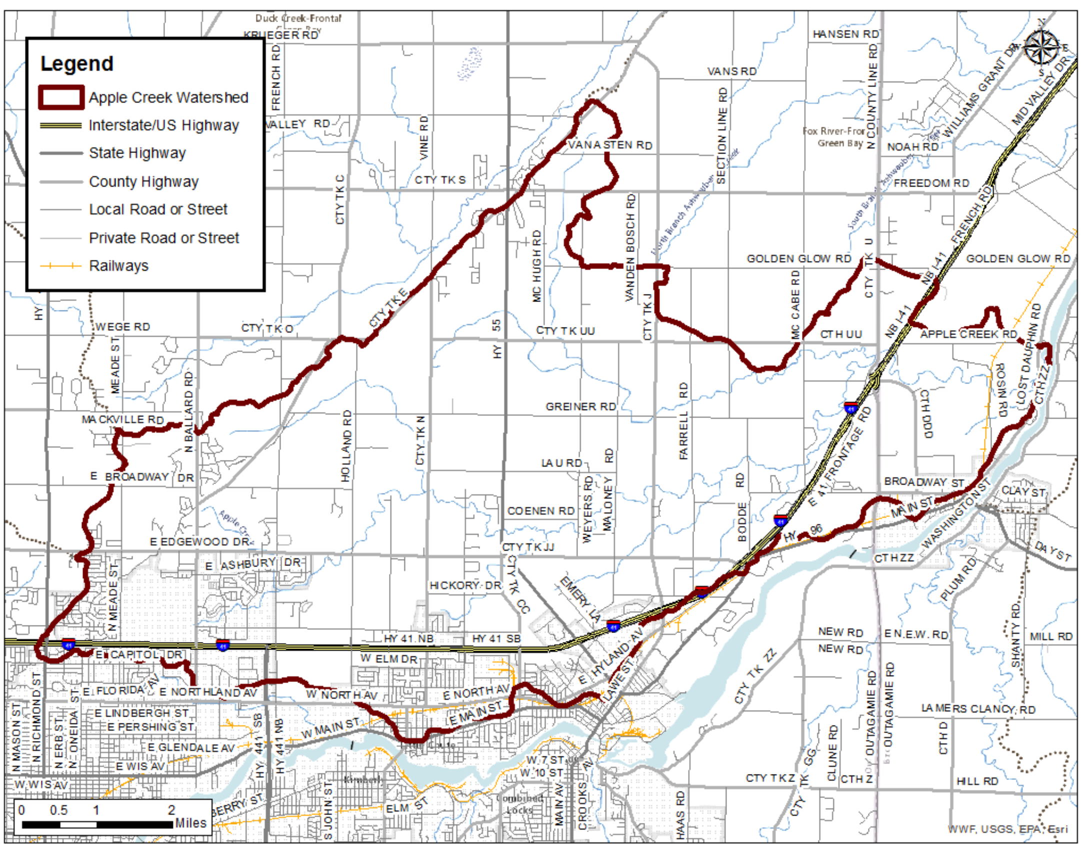

Figure 10. Transportation.

2.4 Population Demographics

The southern portion of the Apple Creek watershed is urban area while the northern portions are rural and less populated. The population in the rural areas of Apple Creek Watershed are expected to increase, based on ESRI's(Environmental Systems Research Institute) population change estimates from 2012-2017 (Figure 11). Predictions on population change were based on the 2010 Census. Urban sprawl from the Fox Valley area could further impact the amount of land available for agriculture in the area in the future as well as negatively impact the water quality.

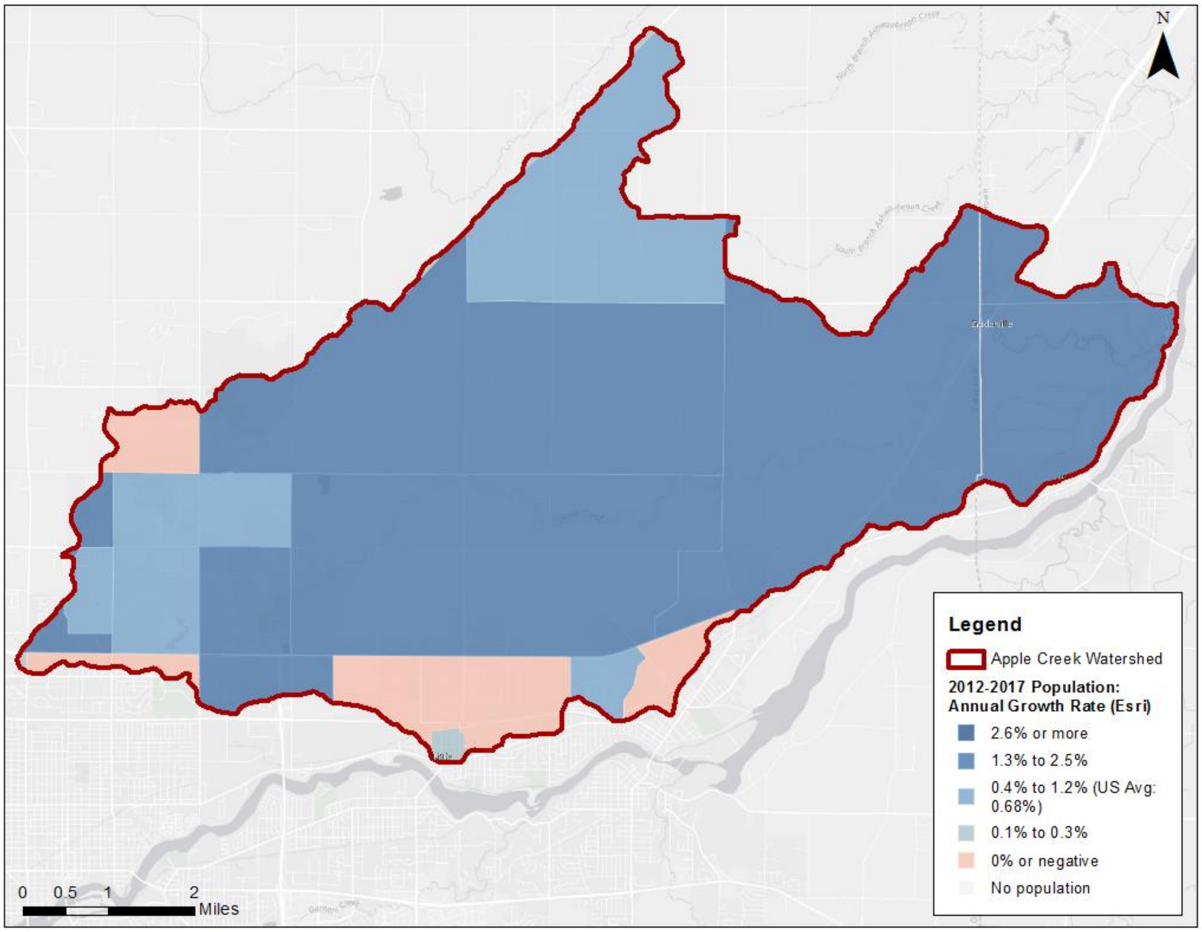

Figure 11. 2012-2017 Population Change. (ESRI 2016)

Median annual income data was collected from 2008-2012 by the American Community Survey. Population data for municipalities and counties are from the 2010 US Census. Median annual income and population for municipalities in the watershed is shown in Table 4.

Table 4. Population and Median House Hold Income. Source: U.S. Census Bureau (US Census Bureau 2010 & 2008-2012 US Census Bureau American Community Survey 5 Year Estimates)

Municipality	Population	Median Income
City of Appleton	74,139	$53,439
City of Kaukauna	15,649	$54,945
Town of Center	3,440	$68,520
Town of Freedom	5,932	$75,809
Town of Grand Chute	21,473	$53,531
Town of Kaukauna	1,269	$85,750
Town of Lawrence	4,557	$71,012
Town of Vandenbroek	1,726	$82,361
Town of Wrightstown	2,409	$75,185
Village of Little Chute	11,026	$57,161
Village of Wrightstown	3,325	$70,433
County		
Outagamie	183,245	$58,421
Brown	258,718	$53,254

3.0 Land Use/Land Cover

3.1 Existing Land Use/Land Cover

Existing land use and land cover in the Apple Creek Watershed was determined in GIS (geographic information system) using digital aerial photography and several spatial land use datasets (See Appendix C). Land Use was broken down into four categories: Agricultural, Natural Background, Urban, and Water. Agriculture is the dominant land use in the watershed at 54% followed by urban land use at 36% (Table 5).

Table 5. Summary of Land Use in Apple Creek Watershed.

Land Use/Cover	Area (Acres)	Percent
Agriculture	17,892	53.9
Natural Background (forests, wetlands, grassland)	3,022	9.1
Urban	11,829	35.6
Water	449	1.4
Total	**33,192**	**100.0**

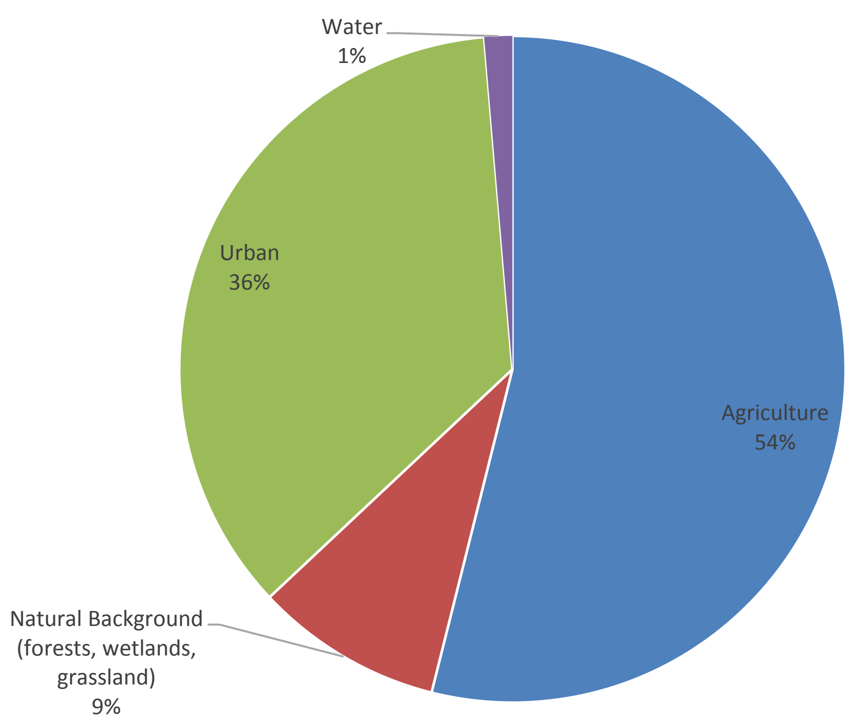

Figure 12. Summary of land use in Apple Creek Watershed.

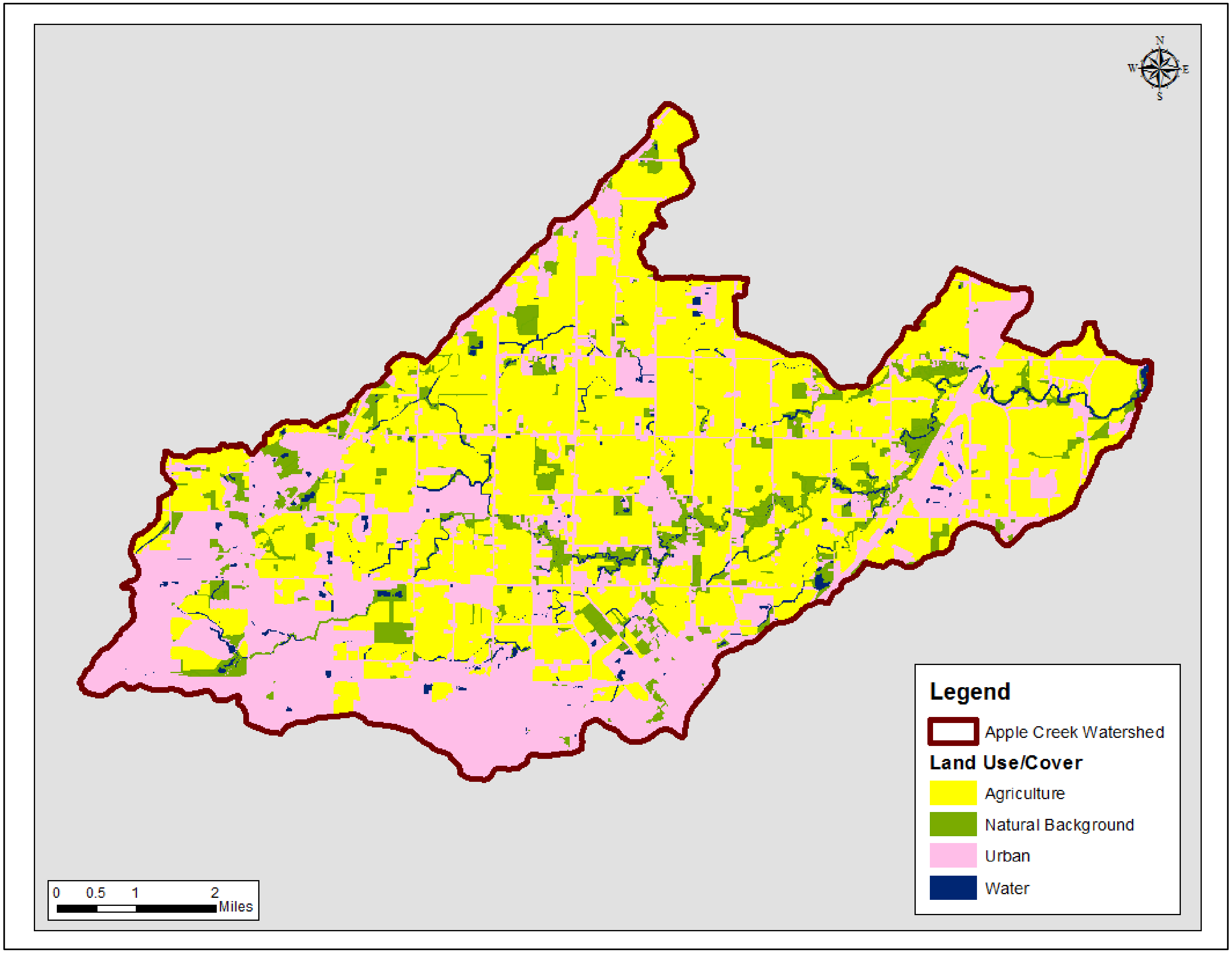

Figure 13. Apple Creek Land Use.

3.2 Crop Rotation

Cropland data was obtained from the USDA National Agriculture Statistics Service (NASS). NASS produced the Cropland Data Layer using satellite images at 30 meter observations, Resourcesat-1 Advanced Wide Field Sensor, and Landsat Thematic mapper. Data from 2009 to 2014 was analyzed using the WDNR EVAAL[1] tool to obtain a crop rotation. Crop rotations for the watershed are shown in Table 6 and Figure 14.

Dairy and Cash grain are the dominant rotations in the watershed at 65.2% and 26.3%. Different crop rotations can affect the amount of erosion and runoff that is likely to occur on a field. Corn is often grown in dairy rotations and harvested for corn silage; harvesting corn silage leaves very little residue left on the field making the field more susceptible to soil erosion and nutrient loss. Changing intensive row cropping rotations to a conservation crop rotation can decrease the amount of soil and nutrients lost from a field. Increasing the conservation level of crop rotation can be done by adding years of grass and/or legumes, add diversity of crops grown, or add annual crops with cover crops.

Table 6. Crop Rotation.

Crop Rotation	Acres	Percent
Dairy Rotation	11,307	65.2
Continuous Corn	764	4.4
Pasture/Hay/Grassland	619	3.6
Potato/Grain/Veggie Rotation	97	0.6
Cash Grain	4,553	26.3
Total	**17,340**	**100.0**

[1] Additional information on EVAAL can be found at http://dnr.wi.gov/topic/nonpoint/evaal.html.

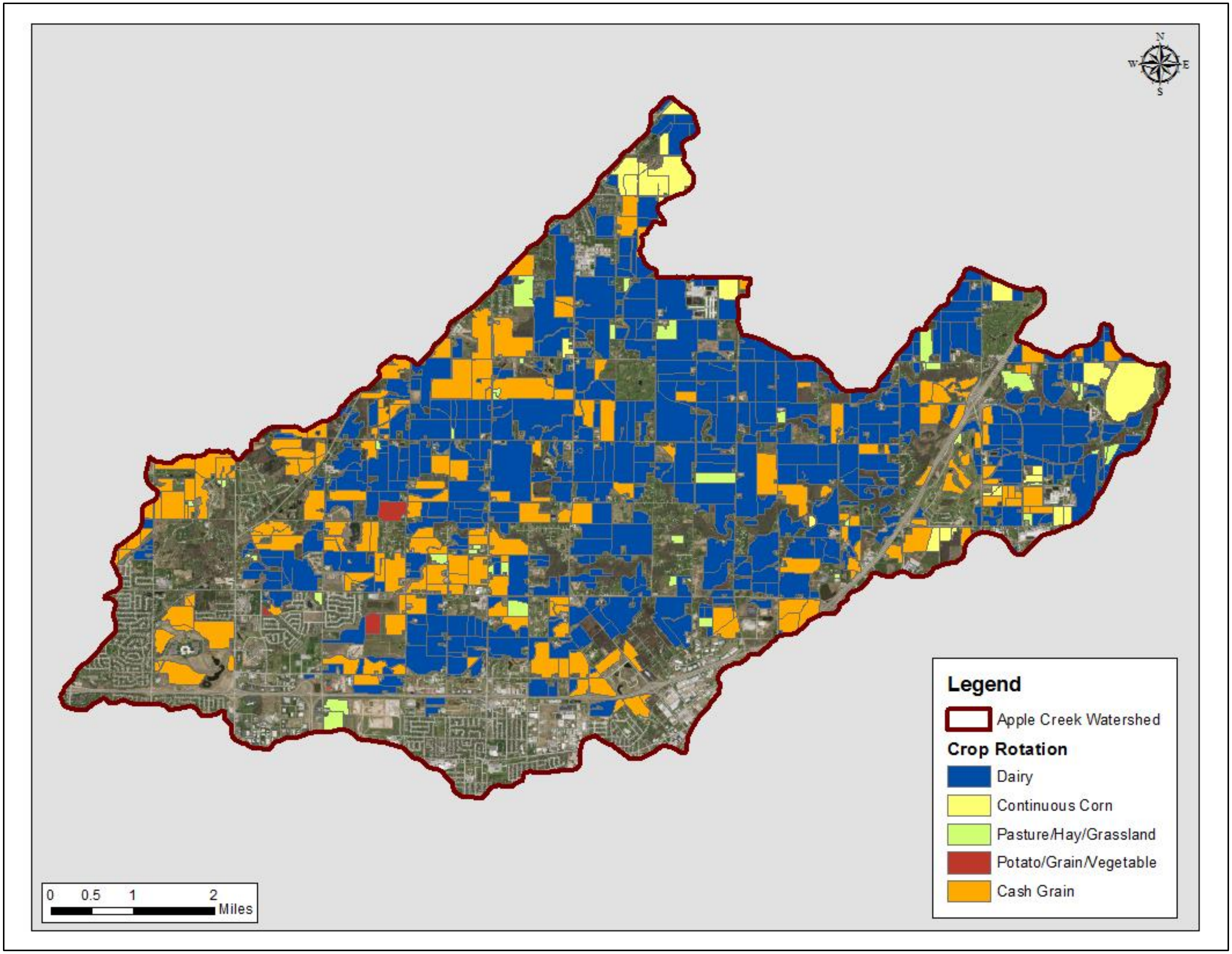

Figure 14. Crop Rotation.

4.0 Water Quality

The federal Clean Water Act requires states to adopt water quality criteria that the EPA publishes under 304 (a) of the Clean Water Act, modify 304 (a) criteria to reflect sit-specific conditions, or adopt criteria based on other scientifically defensible methods. Water quality standards require assigning a designated use to the water body.

4.1 Designated Use and Impairments

A 303 (d) list is comprised of waters impaired or threatened by a pollutant, and needing a TMDL. States submit a separate 303 (b) report on conditions of all waters. EPA recommends that the states combine the threatened and impaired waters list, 303(d) report, with the 303(b) report to create an "integrated report". Apple Creek was first listed as an impaired waterway in 1998. Apple Creek is impaired due to excess phosphorus and sediment loading. Figure 15 shows stream segments in the Apple Creek watershed listed as impaired.

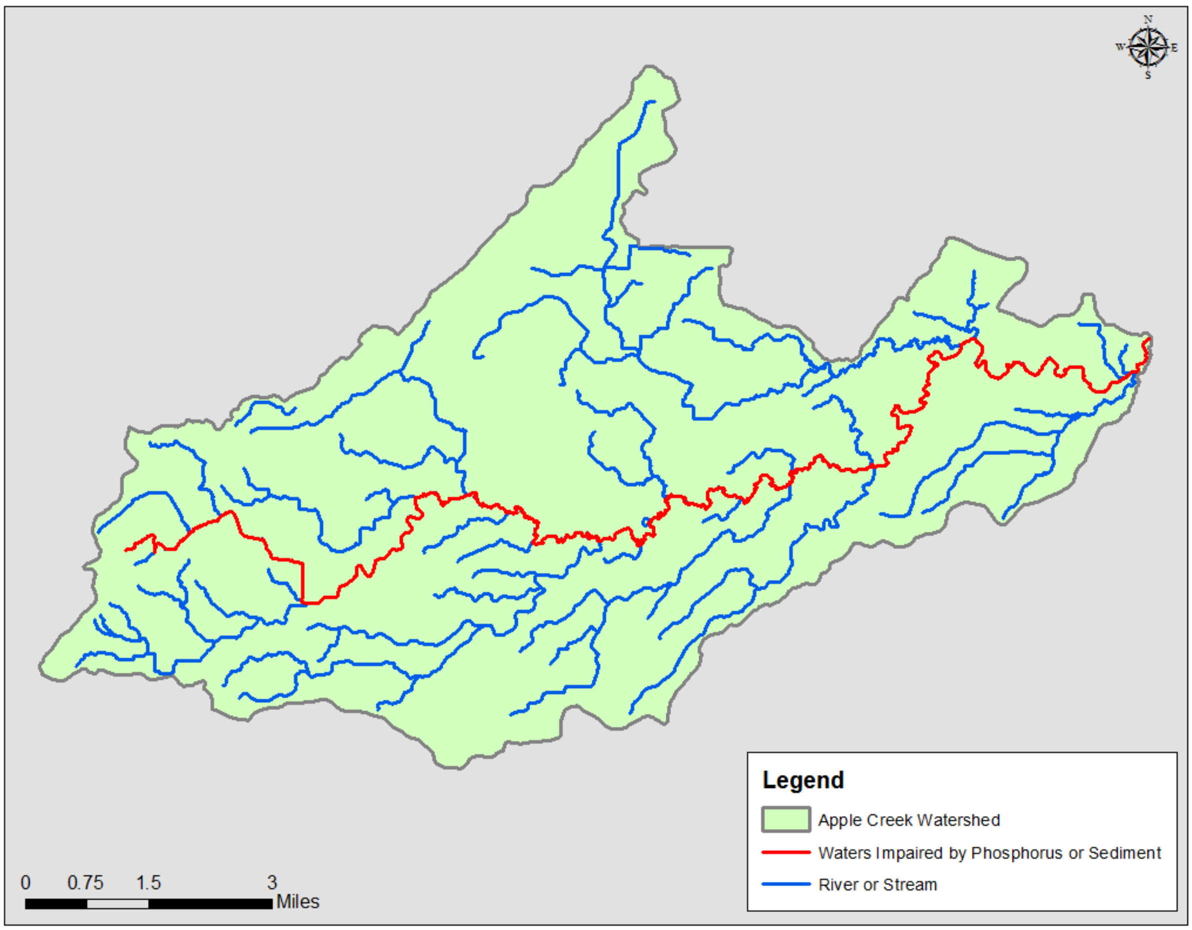

Figure 15. Impaired stream segments.

Streams and Rivers in Wisconsin are assessed for the following use designations: Fish and Aquatic Life, Recreational Use, Fish Consumption (Public Health and Welfare), and General Uses. The Apple Creek is designated for Fish and Aquatic Life. The Fish and Aquatic Life (FAL) designations for streams and rivers are categorized into subcategories. Apple Creek is currently designated to the Warmwater Forage Fish (WWFF) Community. Streams in the WWFF category are capable of supporting a warm water dependent forage fishery. Aquatic life communities in this category usually require cool or warm temperatures and concentrations of Dissolved Oxygen (DO) that do not drop below 5 mg/l. Apple Creek was assessed in the 2014 and 2016 listing cycle and total phosphorus data overwhelmingly exceeded listing thresholds for Fish and Aquatic Life use and biological impairment was observed. The streams and rivers are also being evaluated for placement in a revised aquatic life use classification system where the subclasses are referred to as Natural Communities. Apple Creek's natural community is classified as a Warm Headwater, Cool-Warm Headwater.

4.2 Point Sources

Point sources of pollution are discharges that come from a pipe or point of discharge that can be attributed to a specific source. In Wisconsin, the Wisconsin Pollutant Discharge Elimination System (WPDES) regulates and enforces water pollution control measures. The WI DNR Bureau of Water Quality issues the permits with oversight of the US EPA. There are four types of WPDES permits: Individual, General, Stormwater, and Agricultural permits.

Individual

Individual permits are issued to municipal and industrial waste water treatment facilities that discharge to surface and/or groundwater. WPDES permits include limits that are consistent with the approved TMDL Waste Load Allocations. There are no municipal or industrial individual WPDES permit holders in the Apple Creek Watershed.

Agricultural

State and federal laws also require that Concentrated Animal Feeding Operations (CAFO) have water quality protection permits. An animal feeding operation is considered a CAFO if it has 1,000 animal units or more. A smaller animal feeding operation may be designated a CAFO by the DNR if it discharges pollutants to a navigable waters or groundwater. There are currently four permitted CAFO's in the watershed area. Permits for CAFO's require that the production area has zero discharge

General/Storm Water

To meet the requirements of the federal Clean Water Act, the DNR developed a state Storm Water Permits Program under Wisconsin Administrative Coded NR 216. A Municipal Separate Storm Sewer System (MS4) permit is required for a municipality that is either located within a federally designated urbanized area, has a population of 10,000 or more, or the DNR designates the municipality for permit coverage. Municipal permits require storm water management programs to reduce polluted storm water runoff. Outagamie and Brown County have a general MS4 permit # WI-S050075-2. The general permit requires an MS4 holder to develop, maintain, and implement storm water management programs to prevent pollutants from the MS4 from entering state waters.

Once EPA approves a TMDL that includes permitted MS4s, the next permit issued must contain an expression of Waste Load Allocations (WLA) consistent with the assumptions and requirements contained in the TMDL. MS4 permittees will have the primary role in establishing benchmarks for each 5-year permit term. Urban MS4 municipalities in Apple Creek watershed include City of Appleton, Town of Grand Chute, City of Kaukauna, Town of Lawrence, and Village of Little Chute. TMDL waste load allocations and required reductions for each MS4 are shown in Table 7 & Table 8.

Table 7. Urban MS4 TMDL TSS allocations**.**

Urban (MS4)	Total Suspended Solids Load (lbs/yr)			% Reduction from Baseline	Allocated (lbs/day)
	Baseline	Allocated	Reduction		
Appleton	635,802	381,481	254,321	40.0%	1,044
GrandChute	200,022	120,013	80,009	40.0%	329
Kaukauna	237,775	142,665	95,110	40.0%	391
Lawrence	21,308	12,785	8,523	40.0%	35
LittleChute	316,703	190,022	126,681	40.0%	520

Table 8. Urban MS4 TMDL TP TMDL allocations**.**

Urban (MS4)	Total Phosphorus Load (lbs/yr)			% Reduction from Baseline	Allocated (lbs/day)
	Baseline	Allocated	Reduction		
Appleton	1,617	1132	485	30.0%	3.10
GrandChute	571	399.7	171.3	30.0%	1.09
Kaukauna	563	394.1	168.9	30.0%	1.08
Lawrence	58	40.6	17.4	30.0%	0.11
LittleChute	732	513	220	30.0%	1.40

MS4 permittees subject to TMDL WLAs are required by the DNR to do a TMDL implementation and analysis plan that should be incorporated in the Stormwater Management Plan as required by the permittee's MS4 permit. MS4 permits for stormwater management programs contain requirements for the following:

- Public Education and Outreach
- Public Involvement and Participation
- Illicit Discharge Detection and Elimination

- Construction Site Pollutant Control
- Post-Construction Stormwater Management
- Pollution Prevention Practices for the Municipality
- Developed Urbanized Area Standard
- Storm Sewer System Maps
- Impaired Waters

Examples of stormwater best management practices used by municipalities to meet stormwater pollutant reductions include: detention basins, street sweeping, filter strips, porous pavement, rain barrels, curb cuts, water quality inlets, grassed swales/ditches, green roofs, and rain gardens. Several of these bmp's work by intercepting urban stormwater prior to entering into the MS4 system. The use of these types of practices is recommended and will be beneficial in urban and suburban areas to reduce the load of stormwater and pollutants entering MS4 systems. Often times the use of green infrastructure that simulates natural hydrology by capturing stormwater where it falls and infiltrating, evapotranspiring, or harvesting and using it does not directly implement the terms of a WPDES Stormwater permit. In these cases best management practices that intercept the water from entering the MS4 system may be fundable under EPA 319 funds.

Municipalities in the watershed have been working toward achieving TMDL goals. The City of Appleton, City of Kaukauna, and Village of Little Chute are already meeting the necessary TSS and TP reductions for the TMDL for the Apple Creek Watershed. Links to Municipal Stormwater Reports/Stormwater Management Plans for Appleton, Little Chute, and Kaukauna are listed below.

Municipal Stormwater Reports/Stormwater Management Plans:

City of Appleton:

http://www.appleton.org/government/public-works/stormwater/reports

City of Kaukauna:

http://www.cityofkaukauna.com/departments/storm-water-management

Village of Little Chute:

http://www.littlechutewi.org/380/MS4-Annual-Report

4.3 Nonpoint Sources

The majority of pollutants in the Apple Creek watershed come from nonpoint sources. A nonpoint source cannot be traced back to a point of discharge. Runoff from agricultural and urban areas is an example of nonpoint source. Agriculture is the dominant land use in the Apple Creek watershed and accounts for approximately 78% of the total phosphorus loading and 55 % of the total suspended sediment loading. Nonpoint sources in the watershed include:

- Erosion from stream banks and construction sites
- Runoff from lawns and impervious surfaces
- Failing Septic Systems
- Pet/animal waste
- Erosion/Runoff from agricultural lands
- Tile drainage
- Fertilizer Application

In 2010, new state regulations in Wisconsin went into effect that restricts the use, sale, and display of turf fertilizer that is labeled as containing phosphorus or available phosphorus (Wis.Stats.94.643) The law states that turf fertilizer that is labeled containing phosphorus or available phosphate cannot be applied to residential properties, golf courses, or publicly owned land that is planted in closely mowed or managed grass. The exceptions to the rule are as follows:

- Fertilizer that is labeled as containing phosphorus or available phosphate can be used for new lawns during the growing season in which the grass is established.
- Fertilizer that is labeled as containing phosphorus or available phosphate can be used if the soil is deficient in phosphorus, as shown by a soil test performed no more than 36 months before the fertilizer is applied. The soil test must be done by a soil testing laboratory.
- Fertilizer that is labeled as containing phosphorus or available phosphate can be applied to pastures, land used to grow grass for sod or any other land used for agricultural production.

Wisconsin also has state standards pertaining to agricultural runoff. Wisconsin State Standards, Chapter NR 151 subchapter II describes Agricultural Performance Standards and Prohibitions. This chapter describes regulations relating to phosphorus index, manure storage & management, nutrient management, soil erosion, tillage setback as well as implementation and enforcement procedures for the regulations.

4.4 Water Quality Monitoring

The Lower Fox River TMDL set total phosphorus concentration limits for tributaries as well as phosphorus and suspended sediment loading rates for each subwatershed. The allowable summer median (May-October) phosphorus concentration for tributaries is 0.075 mg/l and allowable suspended sediment concentration for the mouth of the Fox River is 18 mg/l. The allocated TMDL loading rates are 34.39 lbs of P/day and 8.5 tons of sediment/day for the Apple Creek.

Apple Creek is part of the Lower Fox River Watershed Monitoring Program. Currently teachers and students from Appleton East and Appleton North High School monitor water quality in Apple Creek. Appleton East High School monitors at a USGS site by Apple Creek Campground and at the French Road Bridge on the South Branch of the Creek. The French Road site was chosen to compare rural and urban land use impacts within the stream. Apple Creek monitoring locations are shown in Figure 16. Appleton East/North High School analyzes the following water quality parameters: nitrogen, phosphorus, pH, conductivity, dissolved oxygen, temperature, stream flow, turbidity, habitat, and macroinvertebrates. Phosphorus and turbidity data from 2003-2014 at the LFRWMP sites on Apple Creek are shown in Figure 17 & Figure 18.

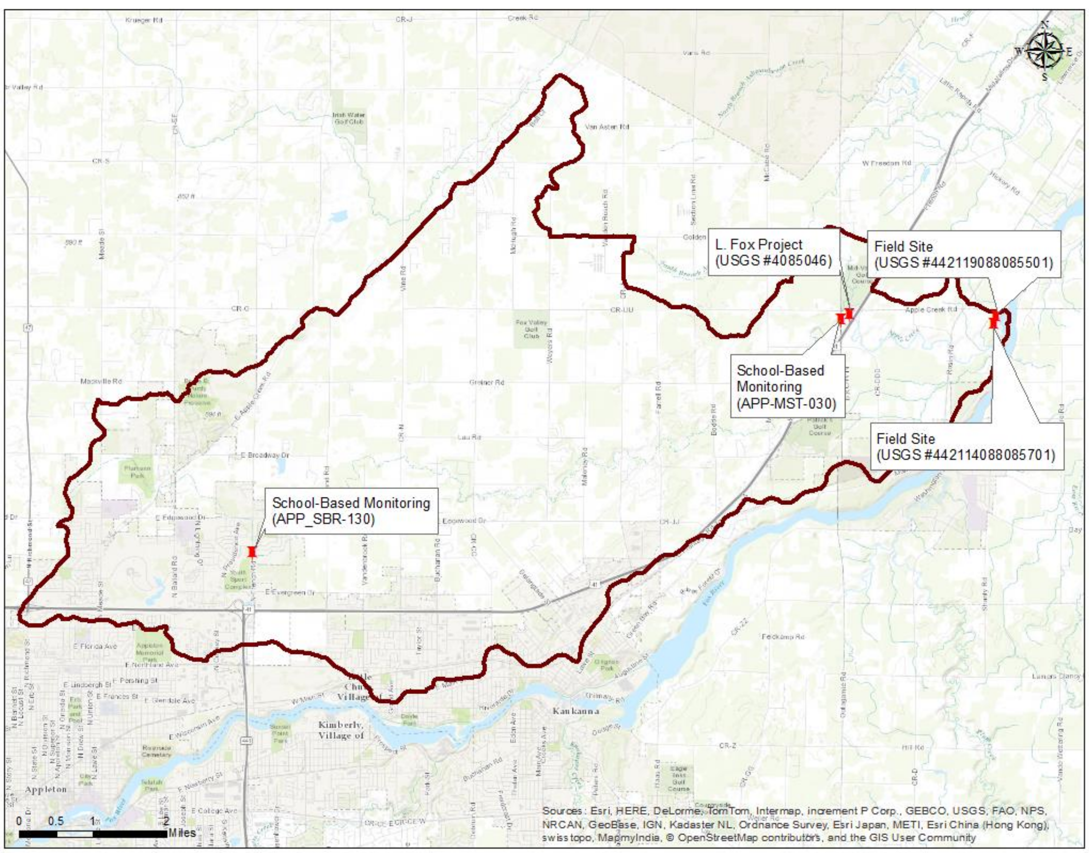

Figure 16. Apple Creek Monitoring Sites.

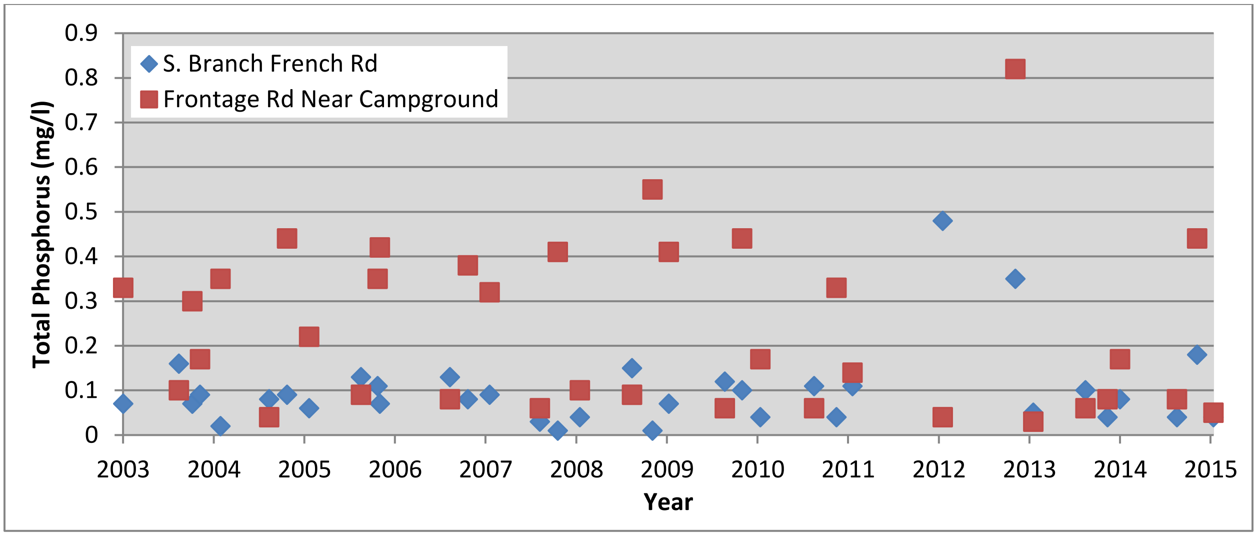

Figure 17. LFRWMP Phosphorus data 2003-2014.

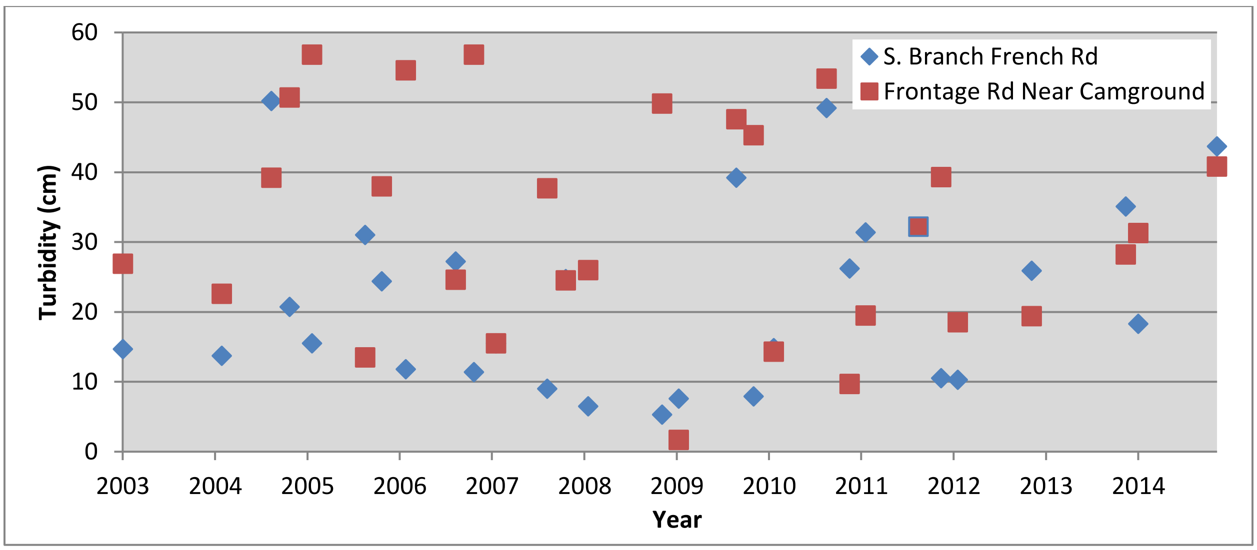

Figure 18. LFRWMP Turbidity data 2003-2014.

Macroinvertebrate data collected from the Appleton East and North High School on Apple Creek from 2004-2014 is shown in Figure 19. The macroinvertebrate index of biotic integrity is a biological indicator for impairment classification. Different types of macroinvertebrates are more tolerant of poor water quality than others. The number and type of macroinvertebrates present in a stream can provide an indicator of water quality. The mean macroinvertebrate index for Apple Creek fell into the poor category for all years except 2005-2006 in which the mean IBI was fair.

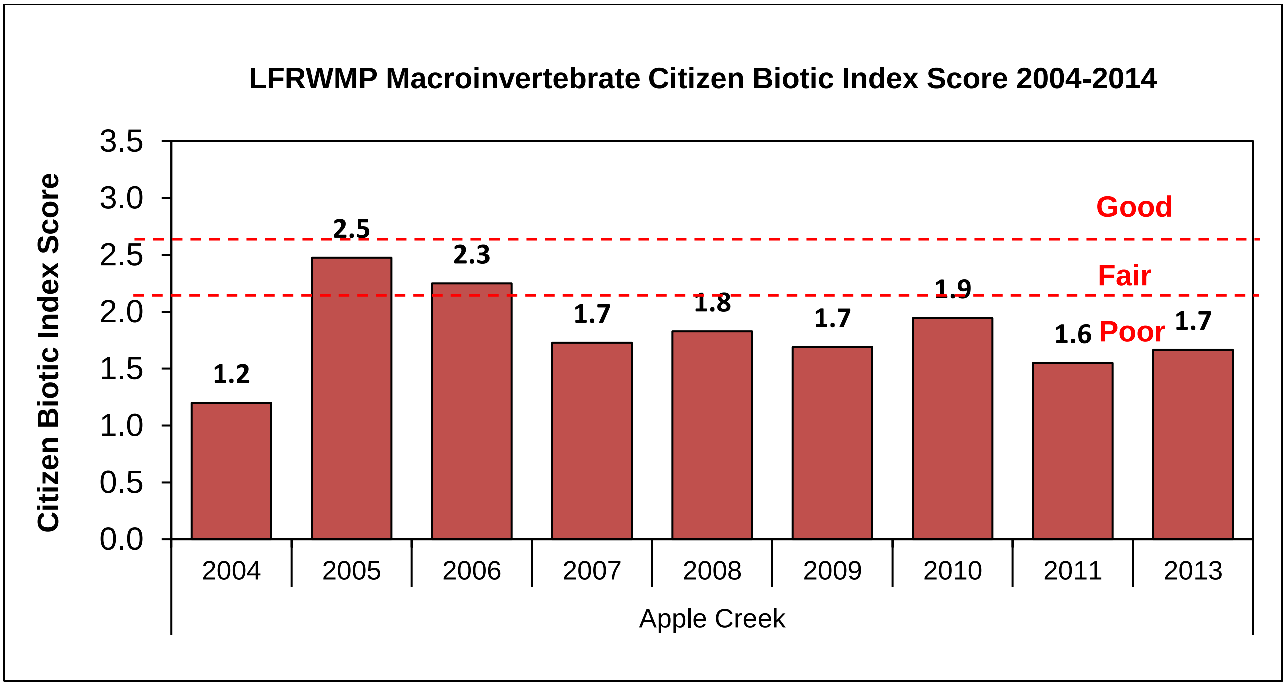

Figure 19. LFRWMP Macroinvertebrate Citizen Biotic Index Score 2004-2014, Apple Creek, WI.

Apple Creek was monitored by the USGS from 2003-2006 at the "Apple Creek" gauge located in Sniderville, WI. The gauge monitored discharge, suspended solids, and phosphorus. This monitoring data was used to develop the Lower Fox River TMDL. The USGS Apple Creek Gauge is no longer active. Annual water quality statistics from 2003-2006 at Sniderville, WI site are shown in Table 9.

Table 9. Annual water quality statistics Apple Creek at Sniderville, WI 2004-2006 (USGS 04085046)

Water Year	00060, Discharge, cubic feet per second	00530, Suspended solids, water, unfiltered, milligrams per liter	91055, Suspended solids dried at 105 degrees Celsius, water, unfiltered, tons per day	91050, Phosphorus, water, unfiltered, pounds of phosphorus per day
2004	42.1	40.7	32.9	133.7
2005	25.0	14.5	5.1	57.02
2006	13.5	19.6	3.9	25.41

The WDNR monitors water quality of aquatic resources in the state through various monitoring programs. Results from the WDNR Lower Fox Tributary Volunteer Monitoring Program for 2015-2016 are shown in Figure 20. The summer median total phosphorus was 0.28-0.30 mg/l from 2015-2016, which is nearly four times higher than the TMDL of 0.075 mg/l. There is additional WDNR water quality data available for Apple Creek dating back to 1980 from various monitoring programs. WDNR water quality data for Apple Creek can be viewed at http://dnr.wi.gov/water/watershedsearch.aspx.

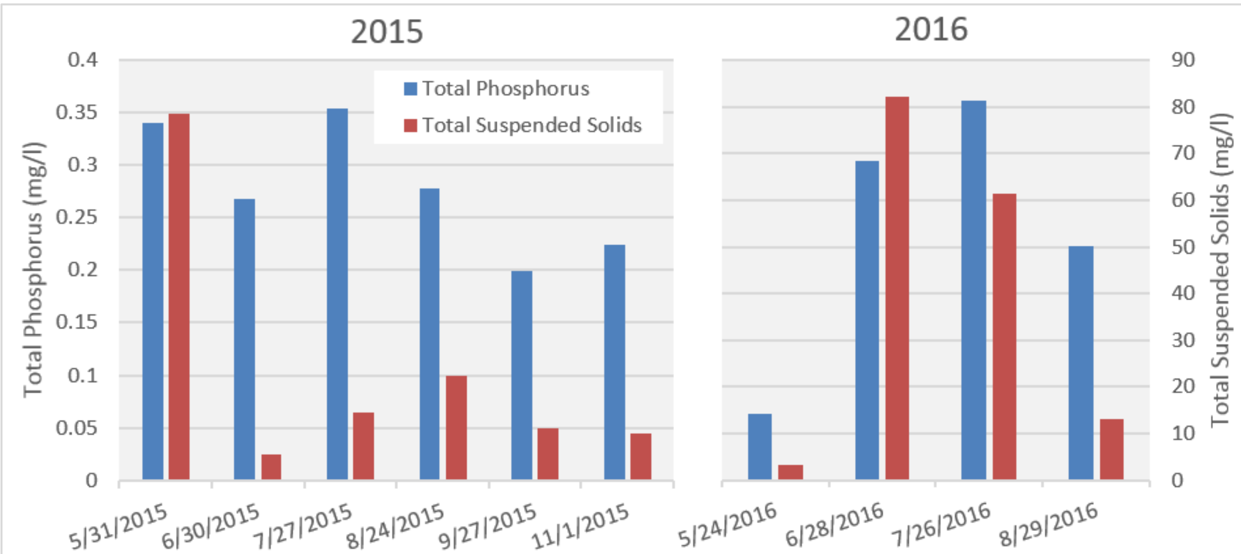

Figure 20. WDNR Lower Fox Tributary Volunteer Monitoring phosphorus (mg/l) and suspended solids (mg/l) 2015-2016. (Apple Creek- Rosin Rd, Station ID: 053684).

Edge of Field Monitoring

There is a USGS edge of field monitoring site in the Apple Creek watershed that is part of the Lower Fox Demonstration Farms Network. This site is a paired watershed site set up to measure changes in water quality from planned conservation practices. Currently these sites are collecting baseline data. Planned practices at these sites include grassed waterways, cover crops, and reduced tillage methods. USGS field monitoring site locations are shown in Figure 16. The edge of field USGS gauging stations are located near Lost Dauphin Rd near the mouth of Apple Creek. Suspended sediment and phosphorus water quality data are shown in (Figure 21 & Figure 22).

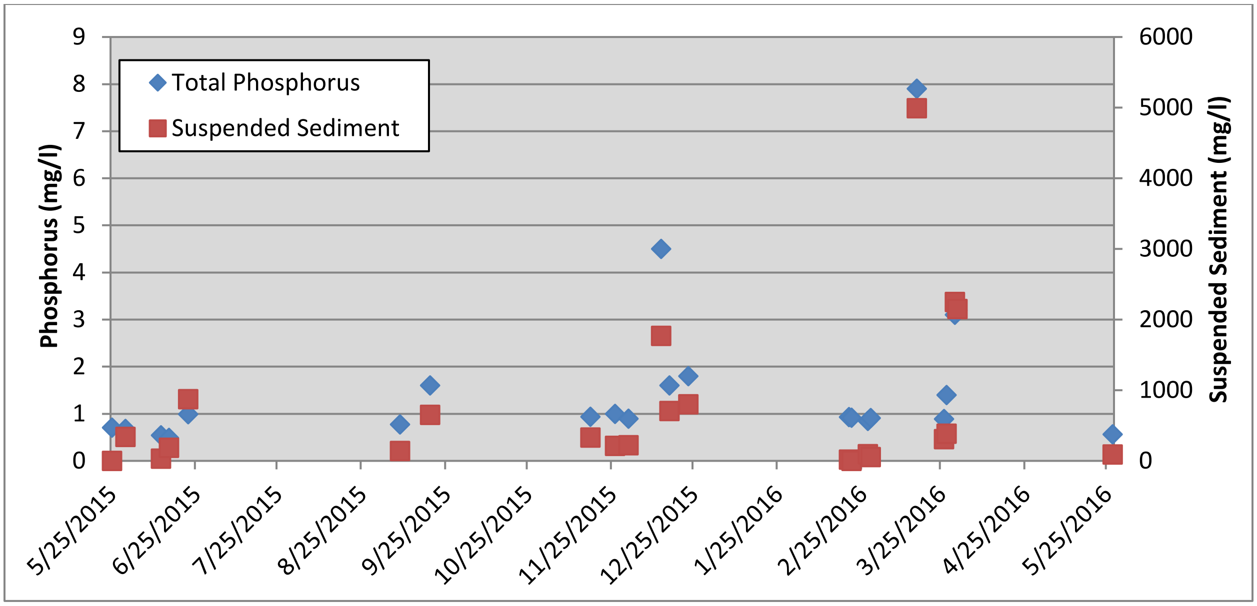

Figure 21. Edge of field site phosphorus (mg/l) and suspended sediment (mg/l) 2015-2016. USGS # 442119088085501, Brown County, Wisconsin.

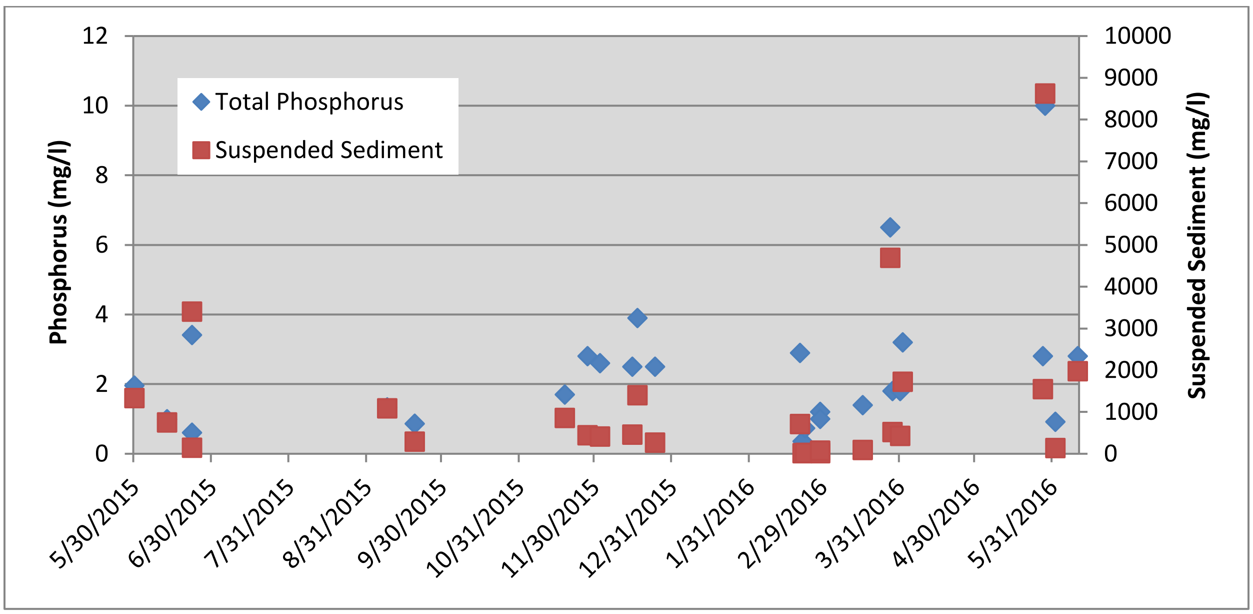

Figure 22. Edge of field site phosphorus (mg/l) and suspended sediment (mg/l) 2015-2016. USGS # 442114088085701, Brown County, Wisconsin.

5.0 Pollutant Loading Model

The developers of the Lower Fox River TMDL plan ran the Soil and Water Assessment Tool (SWAT) for all subwatersheds in the Lower Fox River Basin. The SWAT model is able to predict the impact of land use management on the transport of nutrients, water, sediment, and pesticides. Actual cropping, tillage and nutrient management practices typical to Wisconsin were input into the model. Other data inputs into the model include: climate data, hydrography, soil types, elevation, land use, contours, political/municipal boundaries, MS4 boundaries, vegetated buffer strips, wetlands, point source loads, and WDNR-Enhanced USGS 1:24K DRG topographic maps. The model was calibrated with water quality data taken at USGS sites from the East River, Duck Creek, Baird Creek, Ashwaubenon Creek, and Apple Creek in the Lower Fox River Basin. Much of the data used for the TMDL SWAT model analysis is approximately 10 years old or older.

To characterize the loading from agriculture, natural background, and Non-MS4 urban land use based on current conditions in the Apple Creek Watershed, the STEPL model was used. STEPL[2] (Spreadsheet Tool for Estimating Pollutant Load) is another watershed model that calculates nutrient loads based on land use, soil type, and agricultural animal concentrations. The NRCS BARNY model was used to estimate phosphorus loads from barnyard inventories in the watershed. The STEPL model was not used to estimate urban loading from MS4 communities. The most recent SLAMM[3] model loading estimates were obtained from the MS4 communities of City of Appleton, City of Kaukauna, and Village of Little Chute. More recent data was not available for the Town of Grand Chute and Town of Lawrence, therefore the TMDL baseline loads were assumed for these MS4 communities. Estimated pollutant loading results are shown in Table 10. The TMDL SWAT model analysis for the Apple Creek Watershed can be seen in Appendix B.

The Apple Creek Watershed contributes an estimated 32,333 lbs of phosphorus and 6,268 tons of sediment to the Apple Creek per year. The SWAT model estimated 35,088 lbs of phosphorus and 6,368 tons of sediment per year for the Apple Creek Subbasin. Agriculture including pasture land, gully erosion, and barnyards contributes 78.2% of the phosphorus loading in the Apple Creek Watershed. Agriculture, including pastures and gullies, contributes 55.2% of the sediment loading in the Apple Creek Watershed. Streambank erosion is estimated to contribute 32.5% of the sediment load in the watershed.

[2] Additional information on STEPL can be found at http://it.tetratech-ffx.com/steplweb/default.htm.
[3] Additional information on SLAMM can be found at http://winslamm.com/winslamm_overview.html .

Table 10. Baseline TP & TSS loading results.

Sources	Phosphorus Load (lb/yr)	Sediment Load (tons/yr)
Urban (MS4)	2,040.0	271.2
Urban (Non MS4)	3,171.0	488.4
Cropland	24,168.6	2,499.1
Pastureland	139.9	7.8
Natural Background	520.6	10.0
Feedlots	436.0	N/A
Gully	595.2	954.3
Streambank	1,262.0	2,037.0
Total	**32,333.30**	**6,267.84**

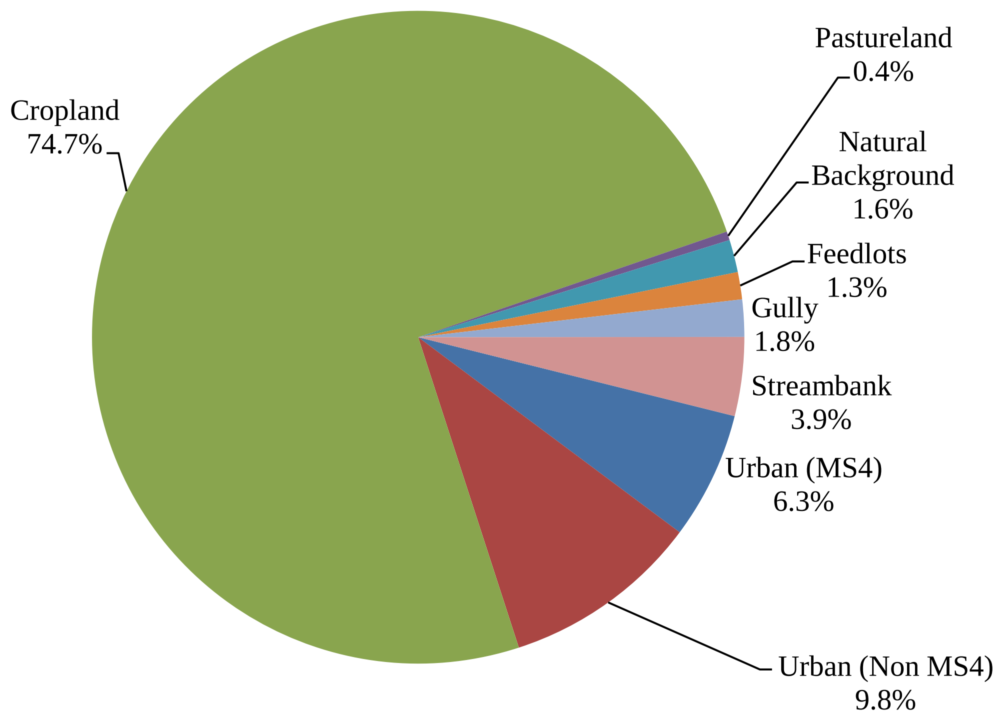

Figure 23. Sources of baseline TP in Apple Creek Watershed.

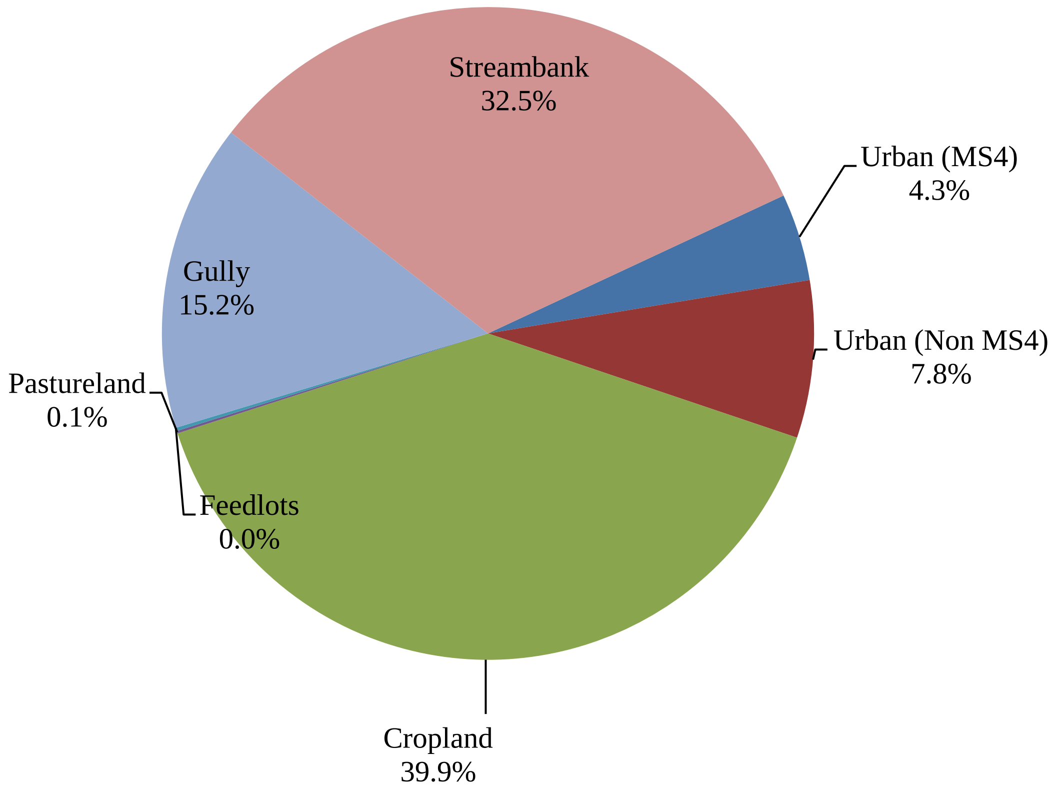

Figure 24. Sources of baseline TSS loading in the Apple Creek Watershed.

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6.0 Watershed Inventory

6.1 Barnyard Inventory Results

Location and data on current livestock operations was compiled through existing Land Conservation Department data, air photo interpretation, and windshield surveys. Additional barnyard data was collected by meetings with farm owners. There are a total of 39 active livestock operations with an estimated 14,960 animal units (AU) including dairy, beef, goat, and veal farms. There are four CAFOS located in the watershed. CAFO's in the watershed account for approximately 66% of all animal units. All CAFO's were assumed to have zero discharge from their production area. Locations of livestock operations in the watershed are shown in Figure 25.

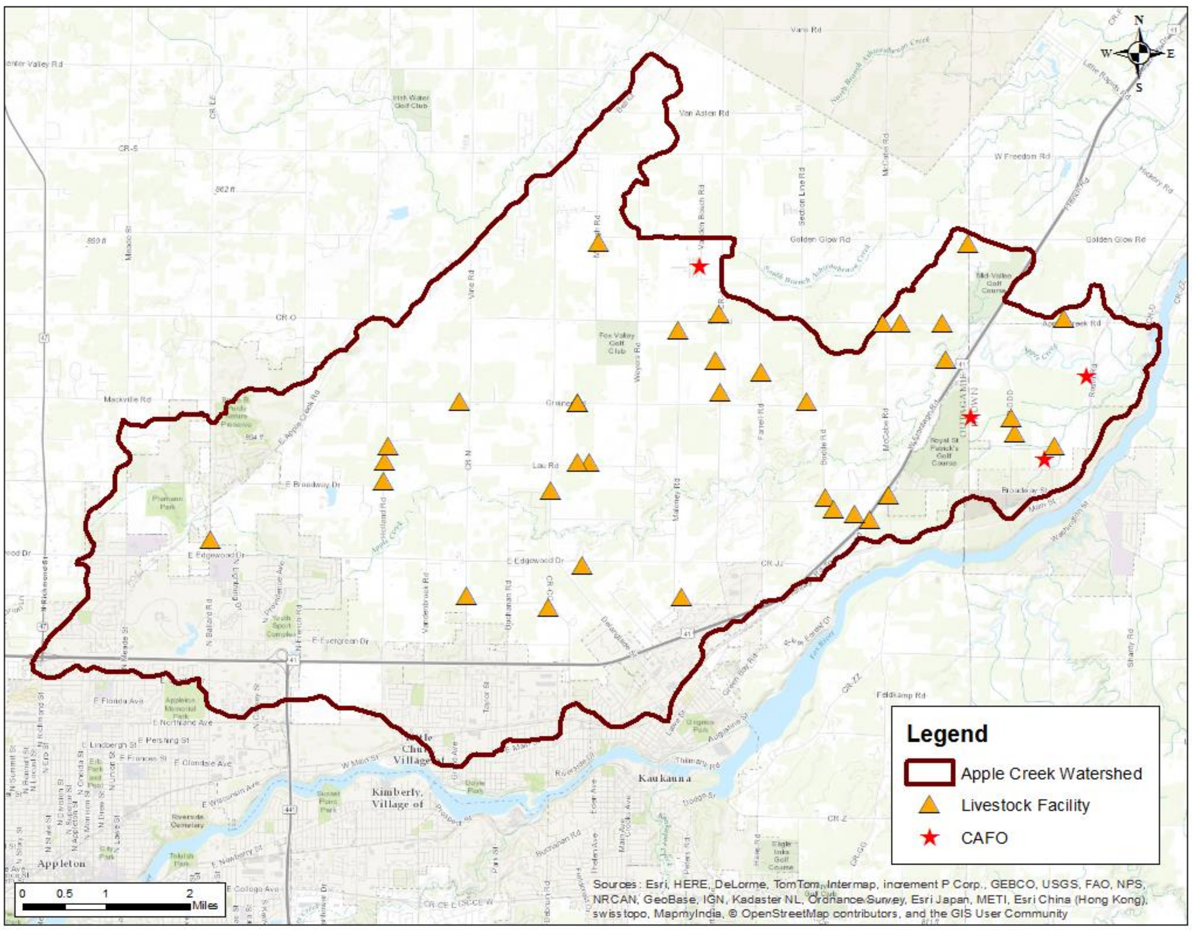

Figure 25. Location of Livestock Facilities in Apple Creek Watershed.

Barnyard data was entered in to the NRCS BARNY spreadsheet tool to estimate phosphorus loading. According to the BARNY calculations an estimated 436 lbs of phosphorus per year can be attributed to barnyard runoff. Barnyard runoff accounts for approximately 1.3% of the total phosphorus loading from agriculture. The majority of farm sites have already had runoff management measures and waste storage installed during the Duck, Apple, Ashwaubenon Priority Watershed Project that ended in 2010. A few of the farm sites may need to expand current manure storage and some sites will need to repair and perform maintenance on already installed practices. Barnyard runoff is not a significant source of phosphorus in this watershed. Barnyards that exceed the annual phosphorus discharge limit of 15 lbs/year will be eligible for cost share assistance to obtain necessary reductions in phosphorus loading. Estimated phosphorus loadings per farm site over 15 lbs P/year are shown in Table 11.

Table 11. Farm sites with 15 lbs/yr P discharge or greater.

Farm #	Phosphorus (lbs/yr)
5060	155.1
5002	51.3
5081	38.8
5111	37.6
5078	29.0
5079	22.4
5080	21.5
5084	20.9
5064	17.8

6.2 Streambank Inventory Results

The Wisconsin DNR 24K Hydrography data set was used to determine the location of perennial and intermittent streams in the watershed area. There are approximately 124 miles of perennial and intermittent streams in the Apple Creek watershed including its tributaries. Some of the intermittent and perennial streams in Apple Creek are legal drains that are inspected annually by the drainage board. The main stem Apple Creek was inventoried for stream bank erosion. Stream bank erosion was inventoried by walking the stream with an Ipad using the ArcCollector application. Information on lateral recession, soil type, height, and length were collected with the app as well as GPS located photos. A total of 21 miles of stream bank was inventoried from Lost Dauphin Rd to Hwy N. Inventory results show significant bank erosion occurring along main stem Apple Creek. Inventoried streambank segments and erosion sites are shown in Figure 27. Inventory data indicates that stream bank erosion is a significant source of sediment in this subwatershed.

Figure 26. Streambank erosion on Apple Creek.

Sediment loss was calculated for the 21 miles of blue line perennial and intermittent streams using the NRCS Direct Volume Method:

$$[(eroding\ area)(lateral\ recession\ rate)(density)] \div \left(2000\,\frac{lbs}{ton}\right) = erosion\ in\ tons/year$$

Lateral recession rate was determined by Table 12 and density was determined by soil type using Table 13. Sediment loss calculations for inventoried sites are shown in Table 14. An additional 489 tons/yr of sediment is estimated to be coming from Apple Creek that was not inventoried. The estimated amount of annual gross sediment loss due to stream bank erosion in Apple Creek is approximately 2,546 tons/year. Adjacent gullies and eroding ravines entering into the stream were also inventoried. The following NRCS equation was used to estimate sediment coming from the adjacent gullies and eroding ravines:

$$[(volume)(soil\ density\ (pcf))/2000)(number\ of\ years\ gully\ has\ been\ active) = soil\ loss\ (tons/year)]$$

An additional 115 tons of gross sediment loss can be attributed to adjacent gully erosion entering the stream.

Table 12. Stream erosion lateral recession rate descriptions. Source :NRCS 2003.

Lateral Recession Rate (ft/yr)	Category	Description
0.01-0.05	Slight	Some bare bank but active erosion not readily apparent. Some rills but no vegetative overhang. No exposed tree roots.
0.06-0.2	Moderate	Bank is predominantly bare with some rills and vegetative overhang. Some exposed tree roots but no slumps or slips.
0.3-0.5	Severe	Bank is bare with rills and severe vegetative overhang. Many exposed tree roots and some fallen trees and slumps or slips. Some changes in cultural features such as fence corners missing and realignment of roads or trails. Channel cross section becomes U-shaped as opposed to V-shaped.
0.5+	Very Severe	Bank is bare with gullies and severe vegetative overhang. Many fallen trees, drains and culverts eroding out and changes in cultural features as above. Massive slips or washouts common. Channel cross section is U-shaped and stream course may be meandering.

Table 13. Soil densities. Source: NRCS 2003

Soil Texture	Volume-Weight (pcf)
Clay	60-70 pcf
Silt	75-90
Sand	90-110
Gravel	110-120
Loam	80-100
Sandy loam	90-110
Gravelly loam	110-120

Table 14. Estimated sediment loss from inventoried stream sites.

Apple Creek	Lateral Recession			
	Very Severe	Severe	Moderate	Slight
length (ft)	3,608	29,323	26,391	1,013
sediment (tons/yr)	378	1,449	229	1

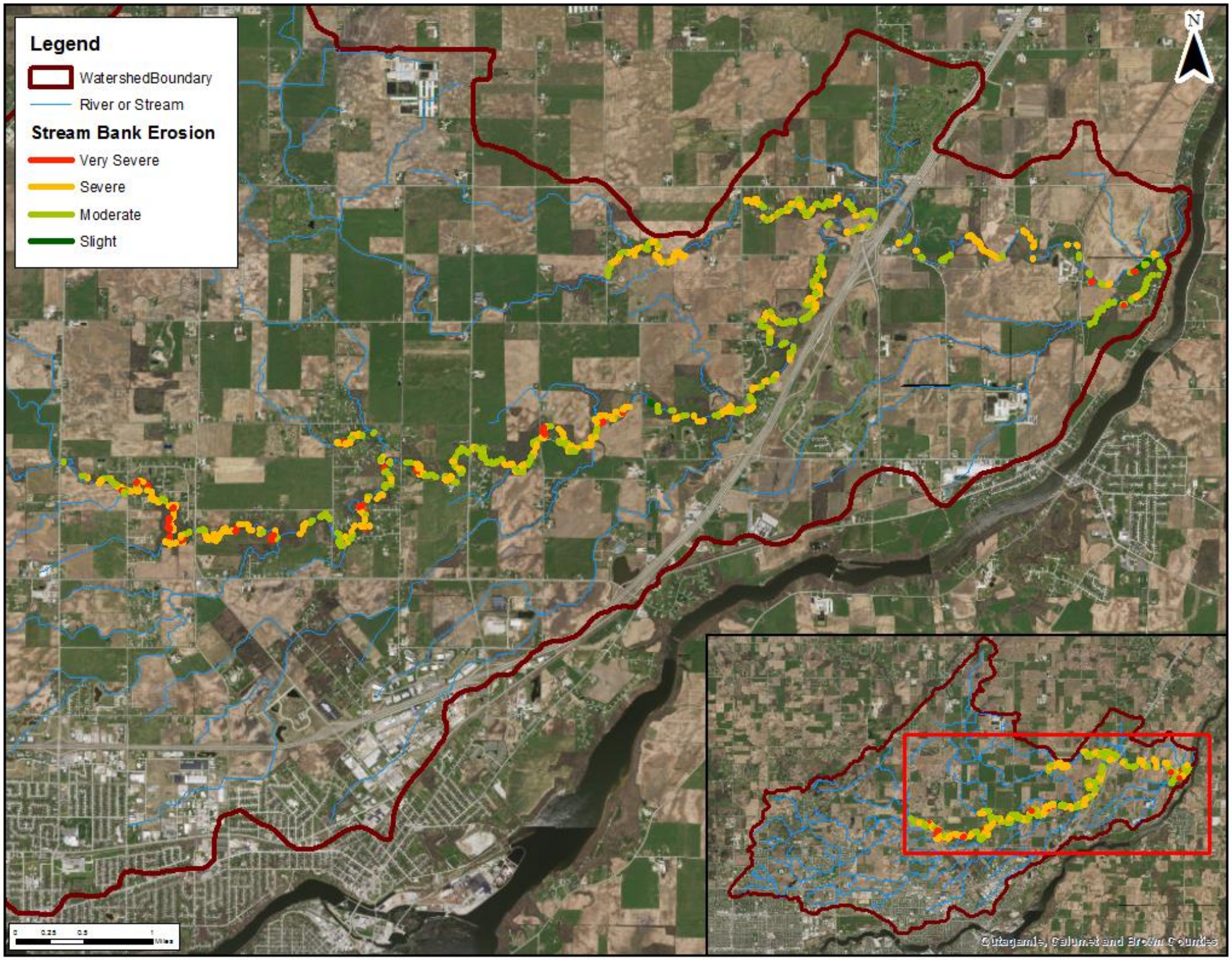

Figure 27. Streambank Inventory Data.

The amount of sediment actually delivered to the Fox River depends on factors such as channelization, straightening, modification, and amount of disturbed channels. By using the NRCS Field Office Technical Guide for Erosion and Sediment Delivery, a sediment delivery ratio of 80% was assumed (Table 15). Using the 80% sediment delivery ratio, the amount of sediment that is actually delivered to the Fox River from streambank erosion is estimated to be about 2,037 tons/year which is 32.5% of the modeled baseline load. There is an estimated 1,262 lbs of P loading attributed to stream bank erosion which is 3.9% of the total phosphorus loading from agriculture. Inventory data indicates that stream bank erosion is a significant source of sediment in this subwatershed. Applying this same sediment delivery ration to inventoried gullies, sediment loading to Apple Creek is estimated at 92 tons/year and 64 lbs of phosphorus/year.

Table 15. Typical delivery rates for concentrated flow erosion. Source: NRCS 1998

Erosion Type	Integrated drainage, Incised Channel (%)	Nonintegrated drainage, Nonincised channel (%)
Ephemeral Gully	50-90	20-50
Classic Gully	80-100	60-80
Streambank	80-100	60-80

Excess runoff to the streams and flooding is likely the cause of the majority of the stream erosion. Regular severe flooding of the Apple Creek is common and affects many landowners in the area. Streambank degradation due to livestock access is not a significant issue in this watershed.

Stabilizing eroding streambanks will help decrease the amount of sediment loading coming from the watershed. Due to the terrain and thick vegetation, many sites of streambank erosion are not easily accessible and therefore not feasible for restoration. Sites were assessed to be feasible for restoration if they had moderate to very severe lateral recession and were easily accessible. Sites with 5 tons of sediment loss per year or greater will be considered high priority sites for stabilization. There are 61 high priority sites where streambank restoration would be feasible (Table 16). Eroding ravines/gullies emptying into the stream were also analyzed for stabilization feasibility. There are 18 gullies that are feasible for stabilization. Gullies that produce more than 3 tons of sediment loss per year will be considered high priority (Table 17). Practices that slow the flow of water to the stream and its tributaries as well as store water will be necessary to prevent further streambank degradation. These practices would consist of wetland restoration, buffers, grassed waterways, water and sediment control basins, reduced tillage, and cover crops.

Table 16. Feasible High Priority Streambank Restoration Sites

SITE ID	Lateral Recession	Length (ft)	Erosion (tons/year)
661	Severe	127.0	31.2
640	Severe	124.5	19.2
557	Severe	745.9	16.9
1211	Severe	133.8	16.8
1191	Severe	208.6	16.7
1188	Severe	100.7	16.5
2177	Very Severe	173.9	16.1
1834	Very Severe	287.0	15.8
1187	Severe	102.9	14.4
2190	Severe	204.8	14.4
1946	Severe	280.3	13.5
637	Very Severe	158.2	13.2
1185	Severe	120.5	11.9
1204	Moderate	161.8	11.4
665	Very Severe	96.0	11.4
1771	Severe	189.6	11.3
1131	Severe	166.4	11.1
1216	Severe	59.4	11.0
638	Very Severe	117.0	10.9
1856	Very Severe	164.9	10.8
2185	Severe	114.7	10.6
1721	Severe	62.1	10.5
628	Severe	109.4	10.4
1148	Severe	35.8	10.3
1873	Severe	160.2	10.1
1192	Severe	686.4	10.1
2183	Severe	102.5	10.0
1933	Very Severe	86.8	9.3
553	Severe	39.3	9.1
2169	Severe	164.3	9.0
2178	Severe	77.5	8.8
1972	Very Severe	79.8	8.7
1142	Severe	79.5	8.7
1223	Severe	54.3	8.2
1713	Severe	121.9	8.1
2219	Very Severe	145.3	8.0

SITE ID	Lateral Recession	Length (ft)	Erosion (tons/year)
659	Severe	50.1	7.7
1215	Severe	199.5	7.5
1193	Severe	55.7	7.2
1195	Severe	43.0	7.2
2171	Severe	298.1	6.9
1998	Severe	102.4	6.8
1200	Severe	331.3	6.5
1990	Severe	90.6	6.4
1869	Very Severe	211.2	6.2
453	Severe	54.8	6.0
2182	Severe	52.9	5.9
1183	Moderate	194.5	5.9
1196	Severe	147.0	5.8
1182	Moderate	33.7	5.6
2187	Severe	23.0	5.6
635	Severe	161.3	5.6
2031	Severe	270.8	5.5
1827	Severe	63.0	5.5
1999	Severe	154.8	5.4
478	Severe	61.2	5.3
560	Severe	76.6	5.3
2194	Moderate	60.7	5.3
1712	Severe	114.1	5.2
1209	Moderate	57.0	5.2
2173	Severe	105.0	5.1

Table 17. High priority gully/ravine stabilization sites.

SITE ID	Lateral Recession	Length (ft)	Erosion (tons/year)
2210	Very Severe	127.0	26.0
2234	Severe	100.5	22.6
1134	Severe	99.8	12.6
2223	Moderate	100.7	11.1
2017	Moderate	142.6	4.8
2228	Very Severe	103.5	3.7
703	Moderate	80.5	3.6
2229	Severe	90.3	3.3
459	Severe	68.3	3.1

6.3 Upland Inventory

Agricultural land was inventoried and analyzed to determine current tillage practices, identify priority locations for best management practice, and to identify the extent of current BMP implementation in the watershed. Agricultural uplands were inventoried by windshield survey, use of GIS data and tools, and with aerial photography. The use of the WDNR EVAAL (Erosion Vulnerability Assessment for Agricultural Lands) and USDA-ARS ACPF [4](Agricultural Conservation Planning Framework) toolboxes were used to determine priority areas for best management practices in the watershed. Other GIS methods used in determining priority areas include the Compound Topographic Wetness Index and Normalized Difference Tillage Index.

Tillage Practices and Residue Management

During the development of the TMDL, data was analyzed from the Conservation Technology Information Center (CTIC) Conservation Tillage Reports (Transect Surveys) from Brown, Outagamie, Calumet, and Winnebago Counties to determine primary tillage practices for the SWAT model input for the Lower Fox River TMDL. Baseline tillage conditions were based on data averages from 1999, 2000, and 2002. The baseline tillage conditions for a dairy rotation were determined to be 83.1% Conventional Tillage, 15.2 % Mulch Till, and 1.7% No till and 75.9 % Conventional Tillage, 20.2 % Mulch Till, and 3.9% No till for Cash Crop Rotation (WDNR 2012).

It is likely that these baseline tillage conditions have changed in the past 10 years so a newer method of analyzing tillage practices and crop residue was used. Crop residue levels and tillage intensity can be analyzed from readily available satellite imagery. Since tillage takes place at different times a series of satellite images were chosen for analysis. Landsat 8 satellite photos from March 19, 2015; May 28, 2015, and November 29, 2015 were used to calculate a minimum Normalized Difference Tillage Index (NDTI). The NDTI estimates crop residue levels based on shortwave infrared wavelengths. The mean minNDTI values per agricultural field for 2015 are shown in Figure 28. As seen below, the mean minNDTI shows baseline tillage conditions similar to the results of the county transect surveys from 1999, 2000, and 2002, indicating that cropping practices have not changed significantly since the transect surveys were done. The mean minNDTI can help easily identify fields that would be good candidates for implementation of reduced tillage practices and cover crops. This analysis of imagery can also be used as a way to track implementation of cropping practices as more years of imagery is collected, since satellites regularly circle the earth.

[4] Additional information on ACPF can be found at http://northcentralwater.org/acpf/

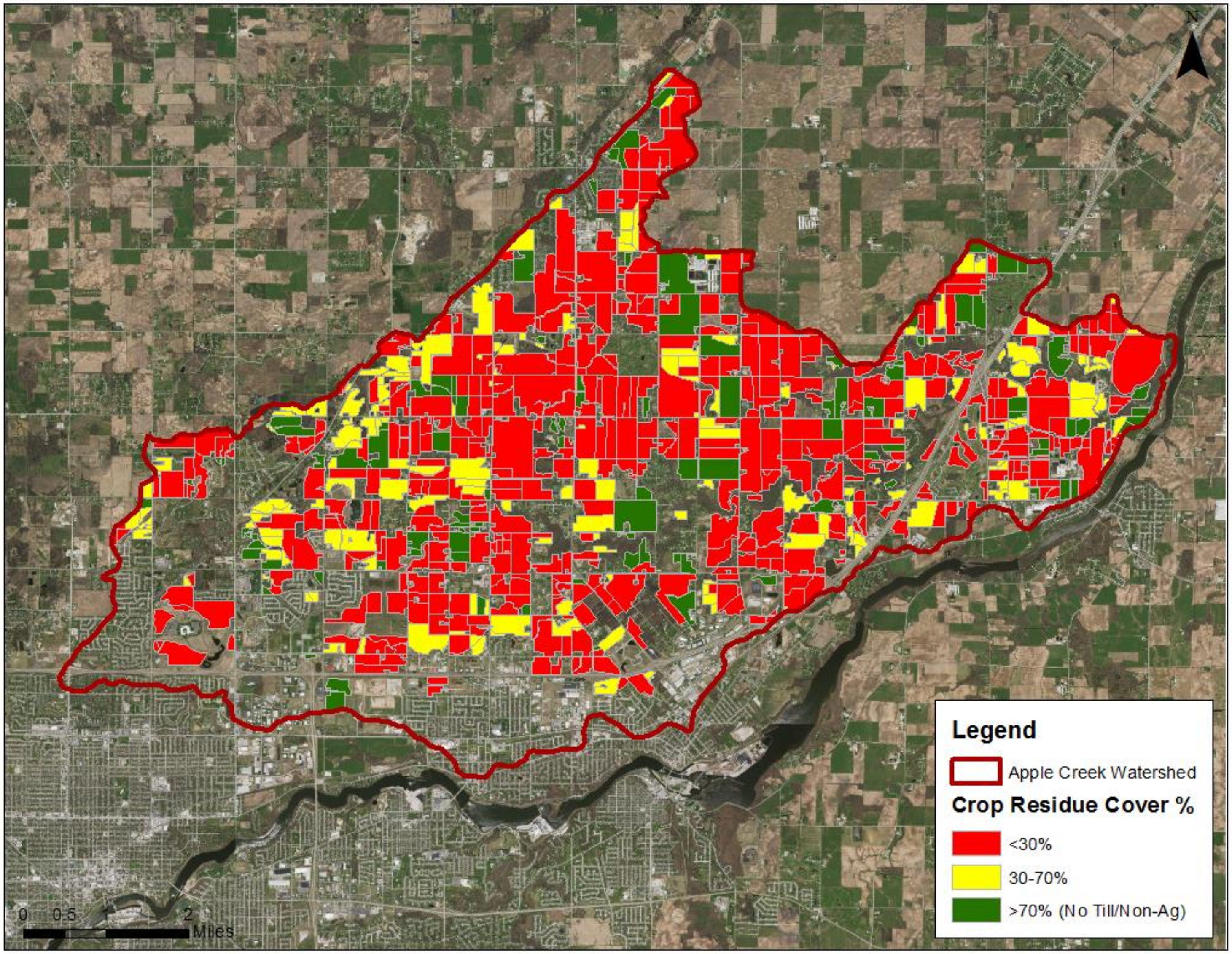

Figure 28. Crop Residue Cover Estimates based on Normalize Difference Tillage Index (March 2015, May 2015, and Nov 2015).

Erosion Vulnerability

The EVAAL (Erosion Vulnerability Analysis for Agricultural Lands) tool was used to determine areas in the watershed that are more prone to sheet, rill, and gully erosion. The tool analyzes the watershed based on precipitation, land cover, and elevation data. The resulting outputs of the tool are an Erosion Score, Stream Power Index, and Soil Loss Index. Figure 29 shows the EVAAL erosion score indicating which fields are more susceptible to erosion based on USLE[5], SPI, and internally draining areas. By running the EVAAL tool twice for the USLE and using the high C-factor for "worst case" and low C-factor for "best case" scenarios, the worst case can be subtracted from the best case which indicates areas with the greatest potential for improvement (Figure 30). These maps are an important tool in indicating which fields are contributing the most sediment and phosphorus in comparison to other fields in the watershed, therefore indicating where best management practices are going to benefit the most in the watershed.

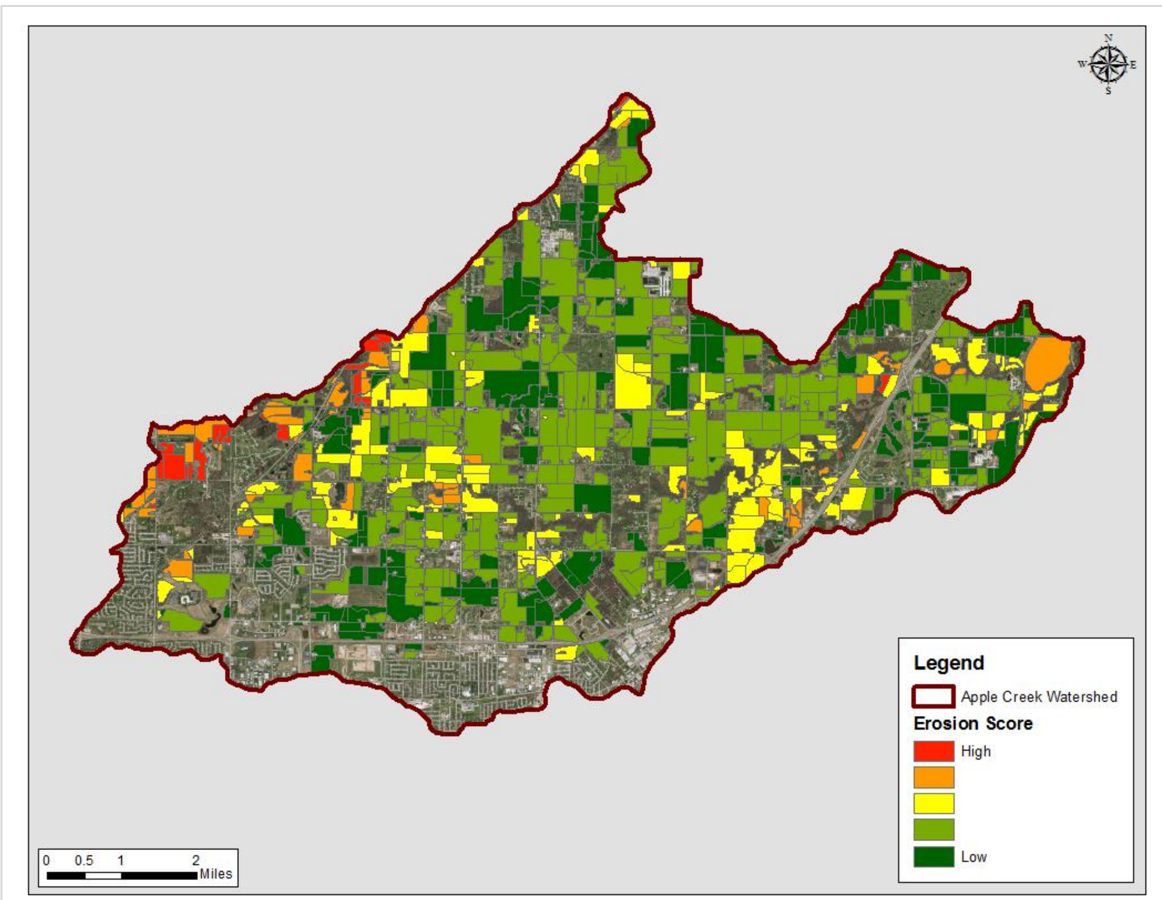

Figure 29. EVAAL Erosion Score.

[5] USLE refers to the Universal Soil Loss Equation that estimates average annual soil loss caused by sheet and rill erosion base on the following factors: rainfall and runoff (A), soil erodibility factor (K), slope factor (LS), crop and cover management factor (C), and conservation practice factor (P).

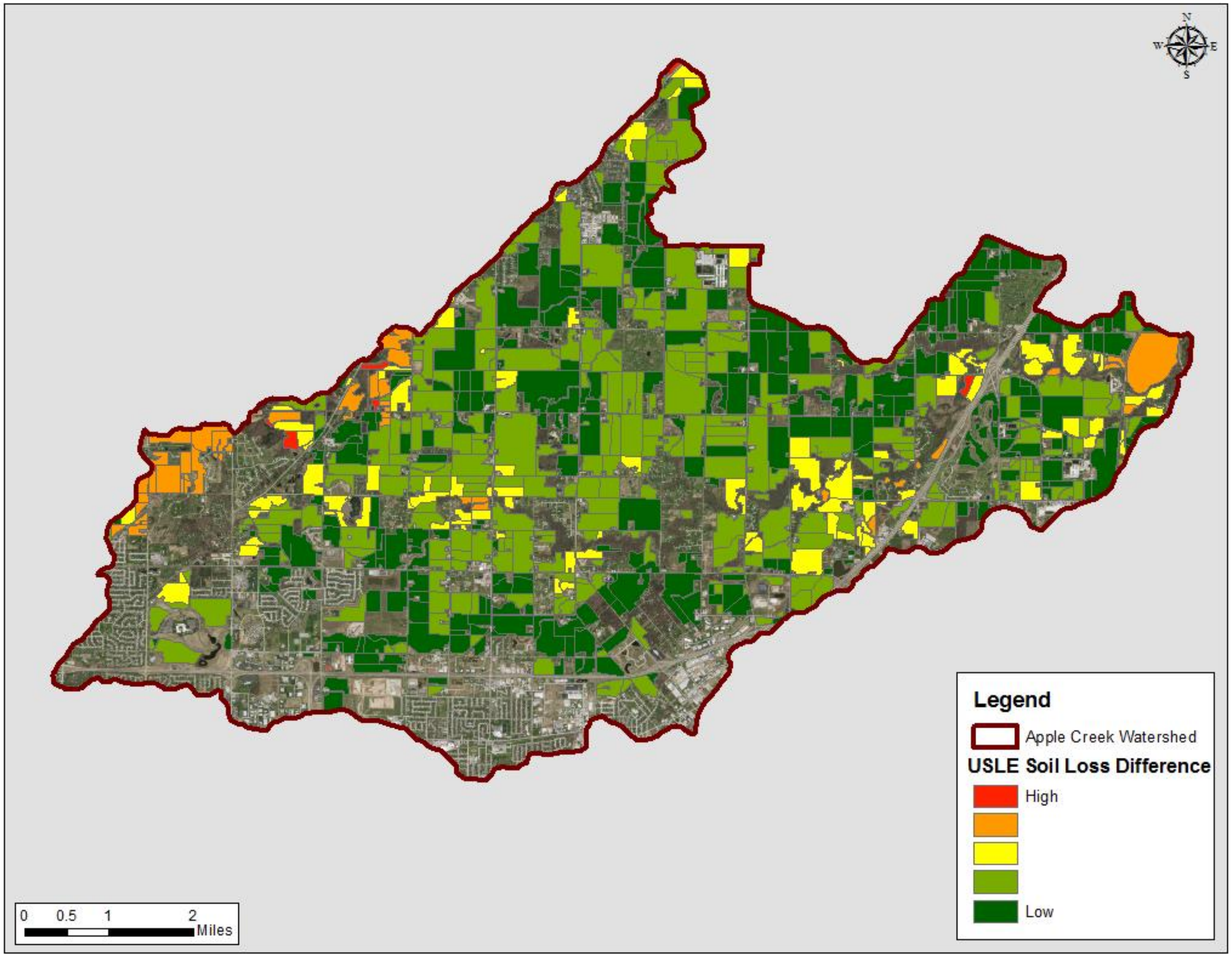

Figure 30. USLE Soil Loss Difference

Nutrient Management Planning

Nutrient management plans are conservation plans specific to anyone applying manure or commercial fertilizer. Nutrient management plans address concerns related to soil erosion, manure management, and nutrient applications. Nutrient management plans must meet the standards of the Wisconsin NRCS 590 standard.

Landowners are required to turn in a copy of their nutrient management plans to the County Land Conservation departments if they have a manure storage permit, received cost sharing for nutrient management, or if they participate in the Working Lands Initiative program. Based on county tracking of plans turned in, approximately 75% of the agricultural land in the Apple Creek Watershed is covered under a nutrient management plan. Nutrient management coverage is shown by field in Figure 31. There are approximately 13,338 acres covered by a NMP and 4,348 acres not shown in covered in the watershed. Even though a large amount of land in this watershed is covered by nutrient management plans water quality still remains poor. This may be attributed to additional nutrient management planning needed and/or the current use of nutrient management planning may not be adequate enough to improve water quality.

The amount of livestock in this area has been increasing while the amount of farm land has decreased. The widespread use of liquid manure to fertilize crops and more crops grown for forage leaving little crop residue to prevent soil erosion is likely a significant contributor to phosphorus loading. There is an estimated 17,892 acres of agricultural land in the watershed, and an estimated 14,960 animal units. This adds up to just over 1 acre of agricultural land per animal unit in the watershed area. According to a study done by Saam et al. (2005) having 1-2 acres of cropland per animal unit is likely to result in phosphorus surplus (Table 18). Alternative ways of handling manure and improved nutrient management in this watershed will likely need to be implemented to meet TMDL reductions in phosphorus.

Table 18. Calculated animal: cropland ratio threshold levels for Wisconsin dairy farms. (Saam et al, 2005)

Animal density category	Animal: Cropland Ratio (AU-acre-1)	acres/cow	Implication for nutrient management
Low	<0.75	2	Crop P requirements met by manure, N deficit
Medium	0.75 to 1.5	1-2	P surplus, crop N requirements met by manure
High	>1.5	less than 1	P and N surplus

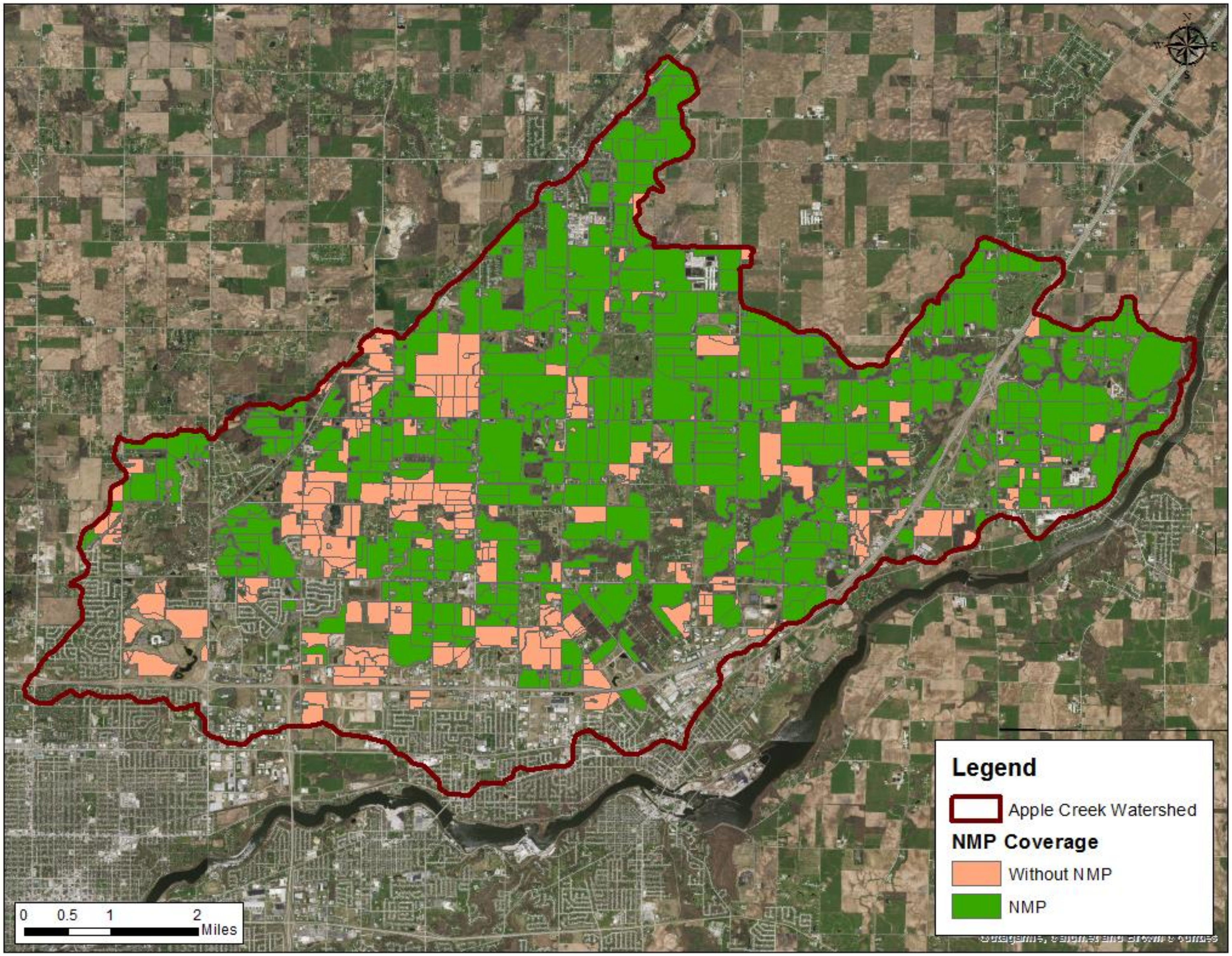

Figure 31. Nutrient management coverage.

Soil Test Phosphorus

Outagamie County and Brown County Land Conservation Departments map phosphorus concentrations for fields under Nutrient Management plans. Soil test phosphorus concentrations of fields in Apple Creek are shown in Figure 32. Tracking of soil test phosphorus concentrations in the watershed will be useful in prioritizing fields for improved management practices and identifying trends in soil phosphorus levels over time.

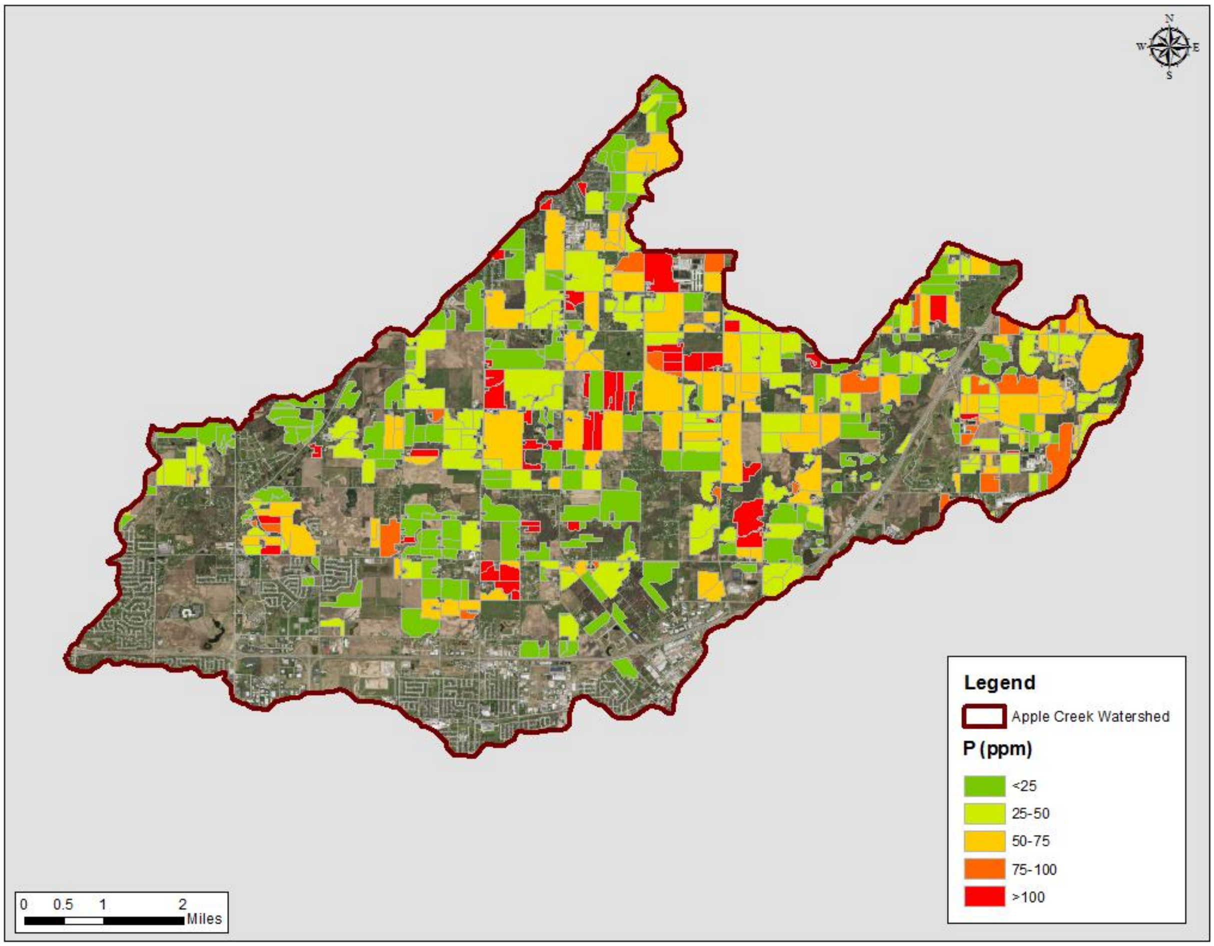

Figure 32. Soil test phosphorus concentrations (ppm).

Grazing/Pastureland Management

By doing one on one inventory with farms in the area we were also able to determine how many farms grazed or pastured their livestock. Approximately 205 acres (0.6%) in the watershed area are currently being used as pasture for livestock. Most of the farmers that do pasture their livestock in the watershed do it for exercise and not as a means of forage with the exception of a few smaller hobby farms with horses and beef cattle.

The STEPL model estimated 140 lbs of phosphorus/year and 8 tons of sediment per year can be attributed to the pasture land use category. Encouraging smaller farms to convert cropland or land used for hay to managed grazing land could result in pollutant reductions but reductions are not likely to be significant. Grazing can also benefit farmers financially by saving them money on fuel costs associated with harvesting, planting, and transportation. Better management of current pastureland can reduce pollutant loading as well.

Tile Drainage

Fields with tile drainage were inventoried by using aerial photographs and then mapped using ArcGIS. There were 8,408 acres of fields that had visible signs of tile drainage in the watershed area (Figure 33), which is approximately 50% of the cropland in the watershed. Tile drains in fields can act as a conduit for nutrient transport to streams if not managed properly. An average of 0.9 lbs P/acre/yr and 240 lbs sediment/acre/yr was found to be leaving via tile drainage on a UW Discovery Farm study in Kewaunee County, Wisconsin (Cooley et al, 2010). The UW Discovery Farm study compared surface phosphorus loss to tile phosphorus loss and found that the tile drainage was 34% of the total phosphorus lost (Cooley et al, 2010). It is likely that a significant amount of phosphorus loading in the Apple Creek area may be attributed to the extent of subsurface tile drain usage. Treating tile drainage at the outlet and better management of nutrient/manure applications on fields can reduce the amount of phosphorus reaching Apple Creek. Some options for treating tile drainage at the outlet include constructing a treatment wetland, saturated buffers, phosphorus removal structures, and installation of water control structures to stop the flow of drainage water during poor conditions. Visible tile drain outlets were also noted while doing stream bank inventory in Spring/Summer of 2016 (Figure 33).

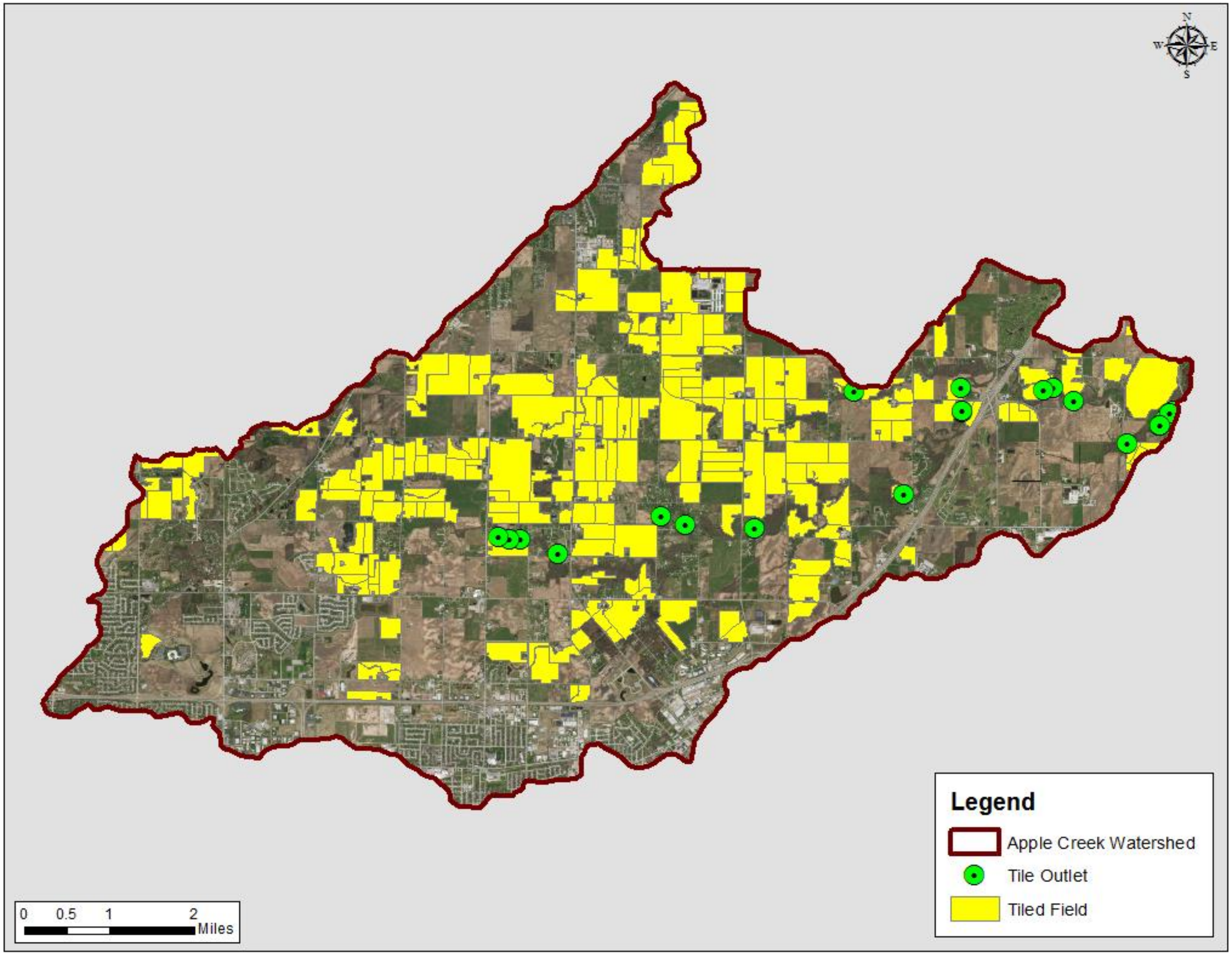

Figure 33. Tile Drainage.

Vegetative Buffer Strips

Riparian Buffers

Riparian buffers filter out sediment and nutrients from water before reaching a stream channel. Buffers also reduce the amount of runoff volume, provide wildlife habitat, and help regulate stream temperature. A minimum 35 ft. buffer for streams is generally recommended for water quality protection. Any intermittent or perennial stream without a 35 ft. buffer will be considered a priority buffer area. In addition to meeting the standard 35 ft. buffer some priority area buffers may need to be extended up to a maximum of 120 ft to provide necessary reductions in pollutant loads based on the WI NRCS Technical Standard 393 for filter strips.

The Apple Creek Drainage District requires a 20 ft. tillage setback from any of the legal drains to allow for annual inspection and maintenance of the legal drains. Encouraging land owners along the drainage district ditches to increase the tillage setback to 35 ft. or more and to improve the quality of vegetation in the setback will also help in nutrient and sediment reductions in the watershed. These buffer areas in the drainage district could also open up opportunities for treatment of tile drainage. There may be additional streams, drainage ditches, and channels not delineated that could also have vegetated buffer strips installed to improve water quality and riparian habitat.

Priority riparian buffer areas were determined using aerial photography, the DNR 24K Hydrography data set, and USGS topography maps (Figure 34). Drainage areas to the buffers were determined using ArcHydro[6]. Mean EVAAL erosion scores were then calculated for the watersheds to the proposed buffers (See Appendix D). The proposed buffers were then ranked for priority based on the size of drainage area treated by the buffer and the mean EVAAL erosion score values of the drainage area.

[6] ArcHydro is an ESRI data model complemented by a set of tools that is used perform advance water resource functions (e.g. watershed delineation and characterization). For more info go to http://www.esri.com/library/fliers/pdfs/archydro.pdf .

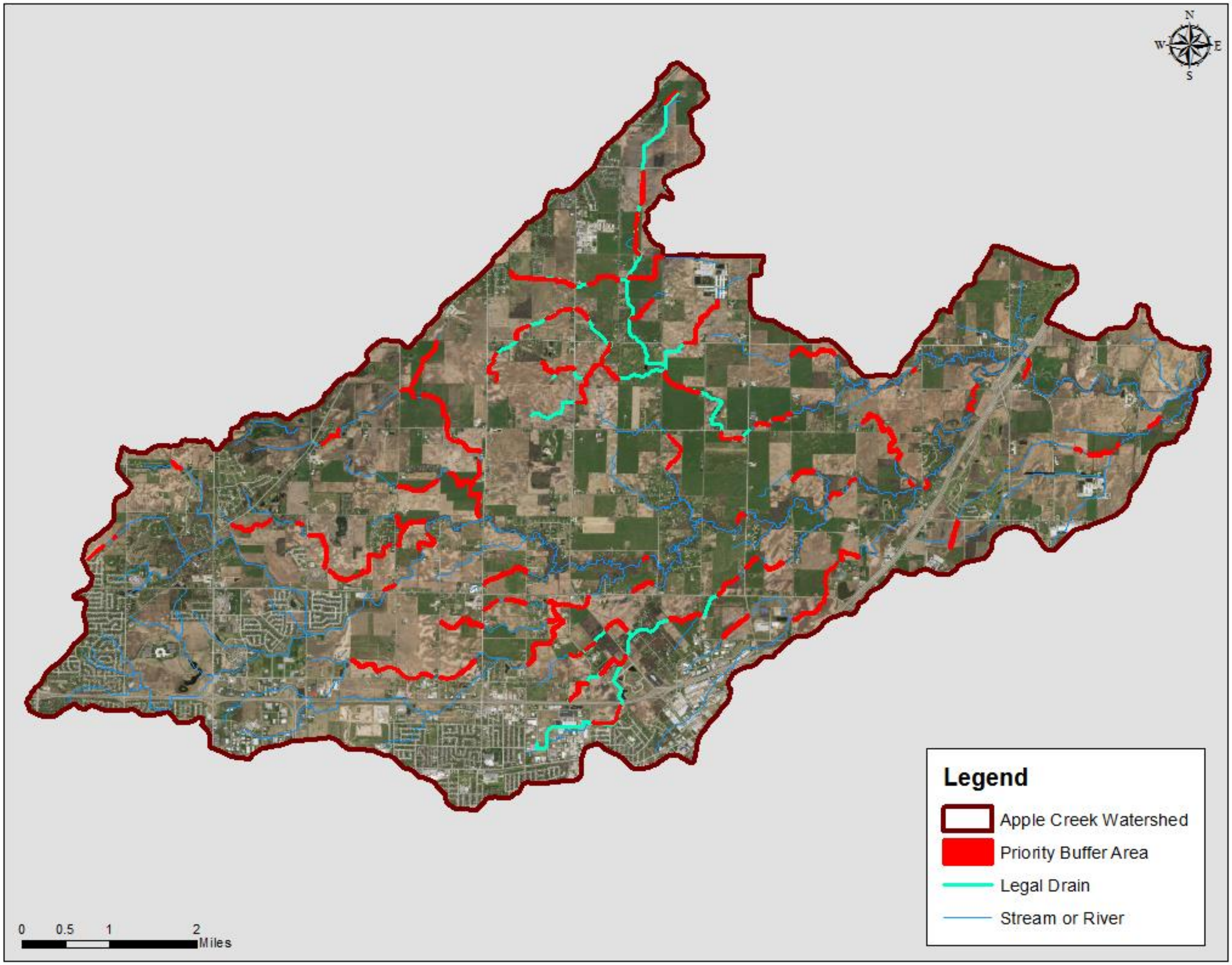

Figure 34. Priority Riparian Buffer Area

Tillage Setback

During windshield surveys of the watershed area there were many fields noted that did not have any tillage setback from drainage ditches. Enforcement of the NR 151.03 tillage setback standard in this watershed where there are resource protection concerns will be necessary in reducing nutrient and sediment loading. The NR 151.03 tillage setback performance standard states that no tillage operation may be conducted within 5 ft from the top of the channel of surface waters[7], and tillage setbacks greater than 5 ft but no more than 20 feet may be required to meet this standard. In addition to meeting the tillage setback to surface waters, additional field borders may be needed along artificial drainage ditches if there is a resource concern.

Gully and Concentrated Flow Stabilization

Gullies and concentrated flow areas were determined by GIS analysis and by windshield survey. Elevation and flow direction data is used to develop a stream power index (SPI) that can indicate areas of concentrated flows that might be gullies. High stream power values are shown in Figure 35. A high stream power index along with air photo interpretation was used to determine where gully stabilization practices may be necessary in the watershed.

Figure 35. High stream power index indicating potential gully erosion.

Recommended gully stabilization practices include grassed waterways, water and sediment control basins (WASCOB), and concentrated flow area plantings. Other practices that may also be used to stabilize gully erosion include lined waterways, grade stabilization, and terraces. A grassed waterway is a shaped or graded channel that is established with vegetation to convey surface water to prevent erosion. Concentrated flow areas that have less severe erosion should also be stabilized but do not necessarily require a grassed waterway. To stabilize these less severe concentrated flow areas while still promoting productive agricultural practices, these areas should be seeded with permanent cover. Unlike a grassed waterway, crops can

[7] "Surface waters" means all natural and artificial named and unnamed lakes and all naturally flowing streams within the boundaries of the state, but not including cooling lakes, farm ponds and facilities constructed for the treatment of wastewaters (NR102.03(7)).

still be planted in the concentrated flow area seeding but the area cannot be tilled. In addition to using grassed waterways and concentrated flow area plantings, water and sediment control basins may be used to reduce runoff and gully erosion. Water and sediment control basins usually consist of an earth embankment or a combination ridge and channel generally constructed across the slope and minor water courses to form a sediment trap and water detention basin. The Agricultural Conservation Planning Framework WASCOB tool was used to site areas for Water and Sediment Control Basins. The tool evaluates potential WASCOB locations approximately every 200 ft along flow paths within a drainage range of 2-50 acres (Porter et al. 2015). Priority areas for gully and concentrated flow stabilization determined by GIS methods and windshield survey are shown in Figure 36.

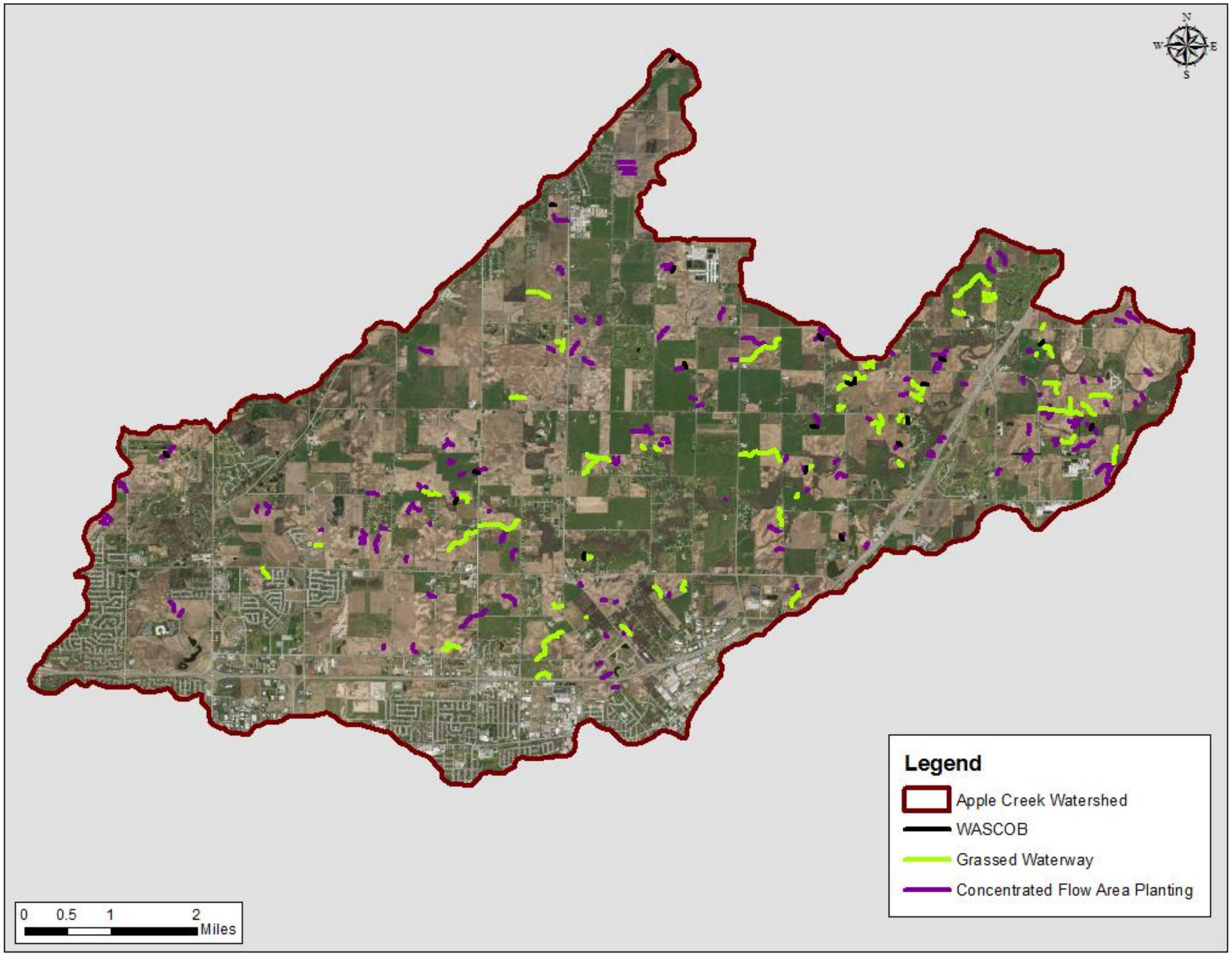

Figure 36. Priority locations for Grassed Waterways, WASCOBs, and Concentrated Flow Area Plantings.

Current Management Practices/Projects

There have been a number of conservation projects installed within the Apple Creek Watershed over the last several years. These projects include barnyard runoff control systems, grade stabilization, waste storage facilities, buffers, wetland restoration, and nutrient management planning (Figure 37). Manure storage facilities have already been installed at 27 of the active production sites in the watershed area. Nutrient management coverage in the watershed is shown in Figure 31 in Chapter 6.3. Many of the conservation practices were installed during the Duck, Apple, and Ashwaubenon Creeks Priority Watershed Project. A moratorium on signing agreements for non-structural practices was placed on September 5, 2001 about halfway through the watershed project term. Therefore implementation of upland practices ceased and did not meet watershed project goals.

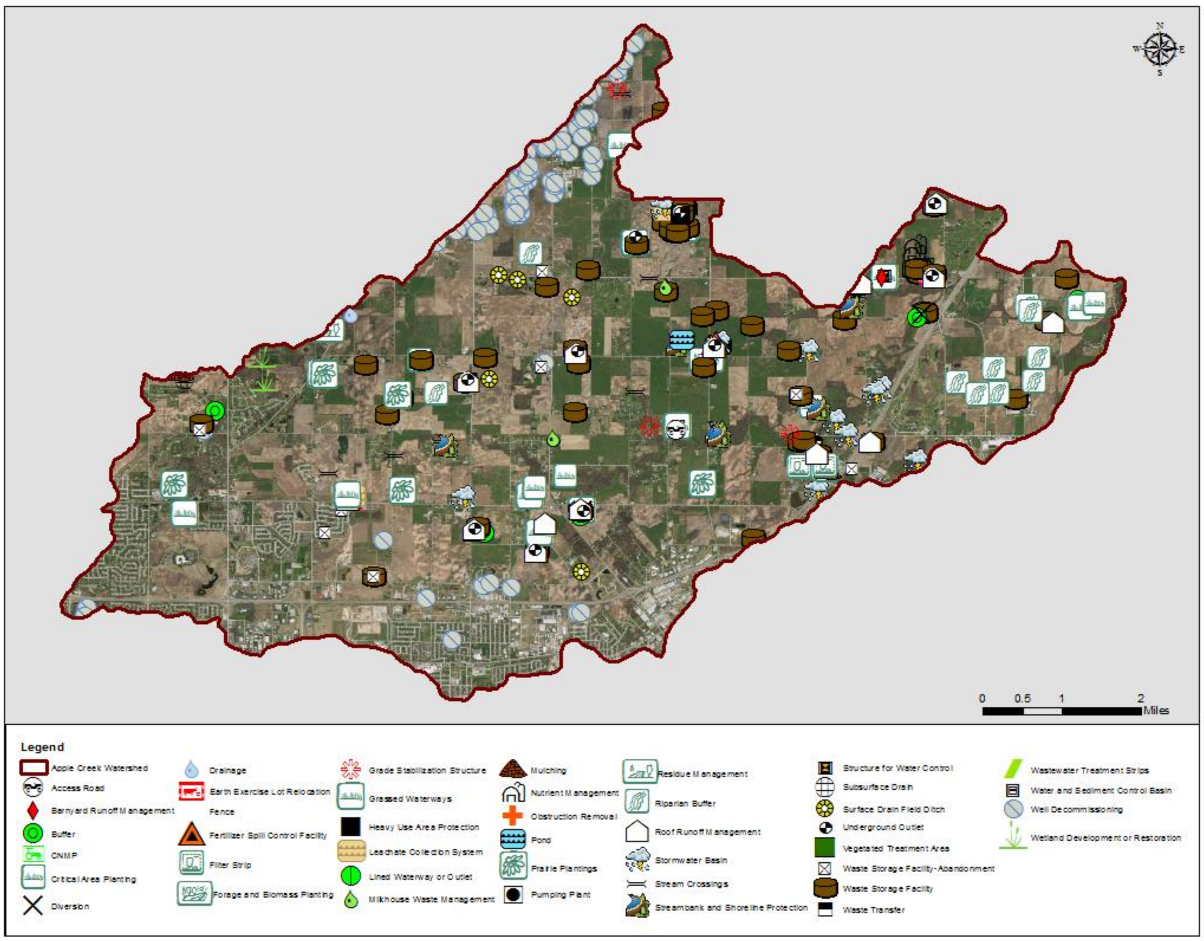

Figure 37. Previous conservation practices installed in the Apple Creek Watershed.

6.4 Wetland Inventory

Wetlands are an important feature of a watershed. Wetlands provide a number of benefits such as water quality improvement, wildlife habitat, and flood control. According to the USEPA a typical one acre wetland can store about 1 million gallons of water (USEPA 2006). Restoring wetlands and constructing designed wetlands in the watershed area will provide water storage and reduce sediment and phosphorus loading. Constructed treatment wetlands can be used to treat water from tile drains, barnyards, upland runoff, and wastewater.

Existing wetland and potentially restorable wetland GIS spatial data was obtained from the Wisconsin Department of Natural Resources (WDNR). A restorable wetland is any wetland that was historically a wetland but has since been drained due to tiling and ditching or has been filled in. The WDNR considers an area a potentially restorable wetland (PRW) if it meets hydric soil criteria and is not in an urban area. There are 631 acres of existing wetlands and 7,431 acres of potentially restorable wetlands in the Apple Creek watershed according to the WDNR wetlands and potentially restorable wetland layer (Figure 38).

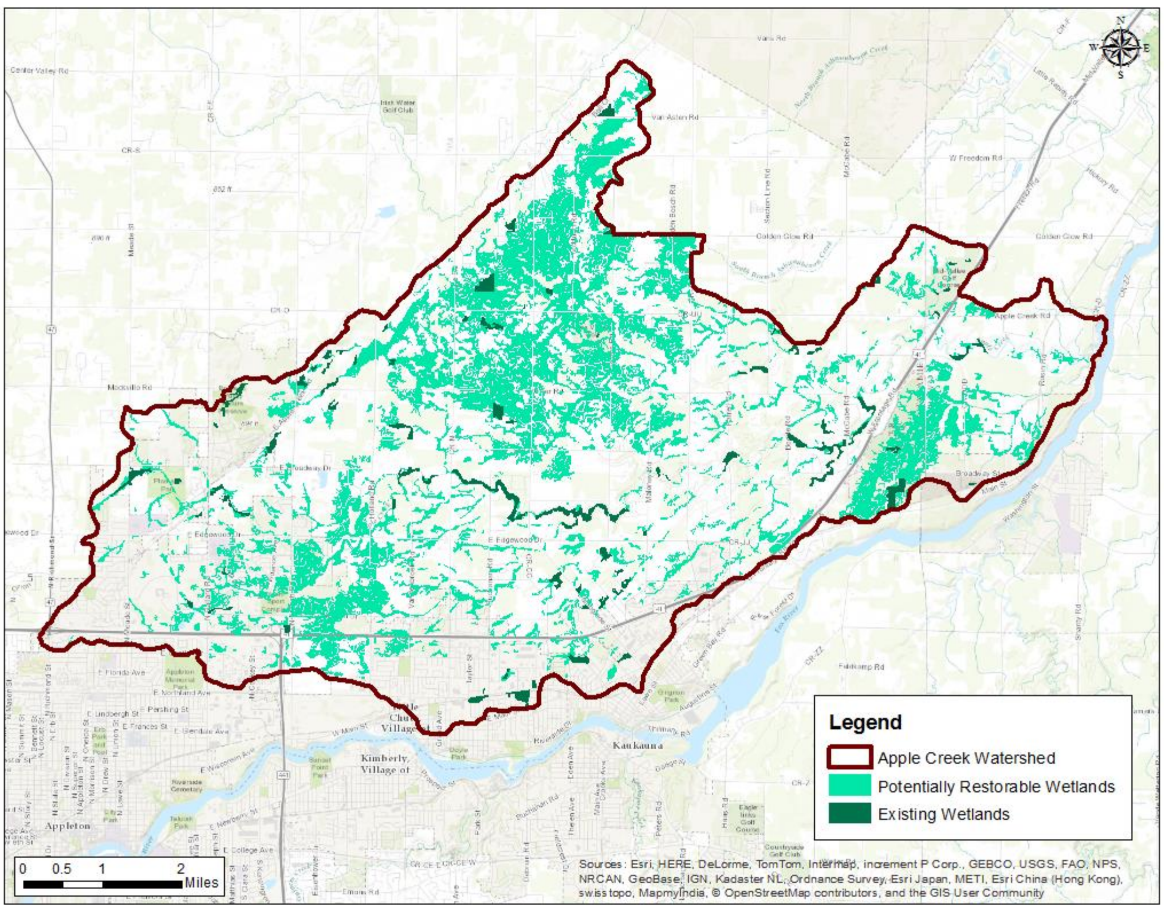

Figure 38. Existing and Potentially Restorable Wetlands
(Wisconsin Department of Natural Resources)

Several GIS datasets were used to prioritize locations for wetland restorations/constructed wetlands in the watershed. The compound topographic wetness index, WDNR PRW, EPA PRW[8], and elevation data was overlain on aerial photography to identify priority locations for wetland restoration/constructed wetlands (See Appendix G for EPA data). The size of a potentially restorable wetland and number of landowners was also taken into account in identifying restorable wetlands. Any PRW that was located in an urban area, encompassed more than one landowner, was larger than 10 acres, or was already a natural area was eliminated. Approximately 25 sites were identified for wetland restoration/construction totaling about 71 acres. Potential sites were then ranked for the function of floodwater storage, nutrient retention, and sediment retention based on landform, water flow path, and landscape position. Locations identified for wetland restoration/constructed wetlands are shown in Figure 39.

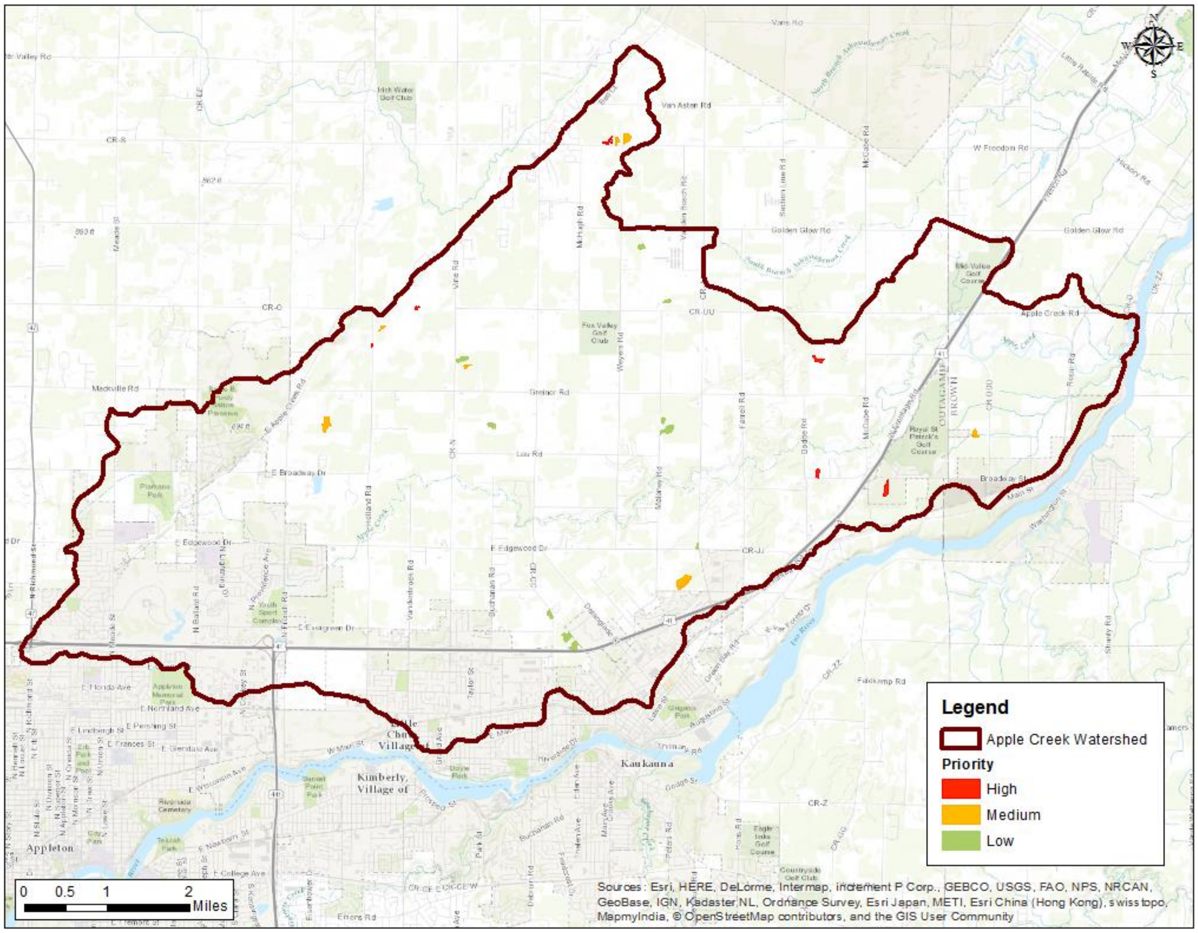

Figure 39. Priority locations for wetland restoration/constructed wetlands.

[8] Additional information on the EPA's Potentially Restorable Wetlands on Agriculture Land can be found at https://www.epa.gov/enviroatlas.

In a study done on the Prairie Pothole Region of the Northern Great Plains, watershed model simulations indicated that 25 percent restoration of wetlands could increase water storage by 27-32 percent and that a 50 percent restoration scenario would increase storage by 53-63 percent (Gleason et al 2007). Since it is very unlikely that most agricultural landowners would be willing to give up cropland to restore wetlands, it will be important to install practices on the landscape such as detention ponds and constructed wetlands designed to store water, retain sediment and nutrients, and mimic pre-settlement conditions in the area.

6.5 Urban Non-MS4

The Lower Fox River TMDL identifies 5,378 acres of Urban Non-Regulated area in the Apple Creek Watershed. According to the SWAT modeling done to develop the TMDL, this land contributes 2,837 lbs per year of Phosphorus and 443 tons per year of Total Suspended Solids.

The TMDL, approved in 2012, did not recommend a reduction from baseline for either phosphorus or total suspended solids for urban non-regulated areas in Apple Creek. The SWAT modeling done for TMDL development estimated phosphorus loading from Urban Non-regulated as 8.1% of the total phosphorus load and 7% of the total TSS load for Apple Creek. Recent STEPL models run on the watershed by Outagamie County Land Conservation staff identify Urban Non-Regulated inputs are closer to 9.8% total phosphorus load and 7.8% TSS load.

As urban non-regulated land use continues to increase in this watershed, the amount of impermeable area will increase, resulting in an increase in runoff. Increased runoff may increase flooding and exacerbate erosion downstream in the watershed. To ensure TMDL goals are realized, it is recommended that townships and villages that fall within the urban non-regulated area assess their stormwater contribution and develop plans for stormwater control.

Solutions that may be identified in Urban Non-Regulated stormwater management plans include but is not limited to: detention basins, bio-filters, street sweeping, filter strips, green roofs, porous pavement, rain barrels, and rain gardens.

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7.0 Watershed Goals and Management Objectives

The main focus of the watershed plan is to meet the limits set by the Lower Fox River TMDL. Additional goals were set that address critical issues in the watershed area based on watershed inventory results. Management objectives address the sources that need to be addressed in order to meet the watershed goals.

Table 19. Watershed Goals and Management Objectives.

Goal	Indicators	Cause or Source of Impact	Management Objective
Improve surface water quality to achieve DNR/EPA water quality standards.	Total Phosphorus, Total Suspended Sediment	High phosphorus levels causing algal growth and decreased dissolved oxygen. Cropland erosion and runoff, streambank erosion, and urban runoff.	Reduce the amount of sediment and phosphorus loads from cropland, streambank erosion, and urban runoff.
Citizens of the watershed area are aware of water quality issues and are involved in the stewardship of the watersheds.	Interview/Questionnaire results	Lack of awareness of environmental issues and their impact.	Increase public awareness of water quality issues and increase participation in watershed conservation activities.
Reduce the flood levels during peak storm events.	Peak flow discharges and flash flooding of the creeks and their tributaries occurring during heavy precipitation events.	Increased impervious area, tile drainage, and ditching. Inadequate storm water practices. Poor soil health.	Reduce the flow of runoff from upland areas to streams. Increase soil infiltration.
Improve streambank stability and reduce amount of streambank degradation.	Moderate to severe erosion characterized by undercutting, vertical banks, and slumping. Meandering and redirection of flow.	High peak flows to stream, flooding, and inadequate riparian vegetation.	Restore and stabilize degraded streambanks.

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8.0 Management Measures Implementation

The Apple Creek Watershed plan presents the following recommended plan of actions needed over the next 10 years in order to achieve water quality targets and watershed goals. The plan implementation matrix provides a guideline to what kinds of practices are needed in the watershed and to what extent they are needed to achieve the watershed goals. The plan provides a timeline for which practices should be completed, possible funding sources, and agencies responsible for implementation.

Existing runoff management standards have been established by the State of Wisconsin. Chapter NR 151 provides runoff management standards and prohibitions for agriculture. This plan recommends enforcement of the state runoff standards when implementing the plan. NR 151.005 (Performance standard for total maximum daily loads) states that a crop producer or livestock producer subject to this chapter shall reduce discharges of pollutants from a livestock facility or cropland to surface waters if necessary to meet a load allocation in a US EPA and state approved TMDL. Local ordinances and regulations will also be used to implement conservation practices and compliance. County Land Conservation and NRCS departments will work with landowners to implement conservation practices. Landowners will be educated on programs and funding available to them as well as current state and local agricultural regulations.

Many alternative and new conservation technologies and methods are currently being developed and evaluated. Incorporation of new and alternative technologies and management methods into the implementation plan will be necessary to achieve desired water quality targets. Newer practices will need to be evaluated for effectiveness and feasibility before incorporation into the plan. Examples of new technologies and methods that may be needed to reach reduction goals in the Apple Creek include the following, but are not limited to:

- Application of soil amendments to fields such as Gypsum, Fly ash, or Polyacrylamide (PAM): Soil amendments can reduce phosphorus solubility.
- Saturated Buffer: Diversion of tile drainage to riparian buffer area reducing nutrient loading.
- Phosphorus removal structures: A large landscape scale filter intended to trap dissolved phosphorus. The structure contains a solid phosphorus sorption material that is able to be removed and replaced after it is no longer effective.
- Constructed Treatment Wetlands.
- STRIPS-Science-based Trials of Row crops Integrated with Prairie Strips.
- Detention ponds to treat agricultural runoff.
- Manure management technology

Outagamie County and Brown County LCD are working together trying to implement a “Pay for Performance” system in the Plum and Kankapot watersheds in order to achieve the necessary TMDL reductions. In order to achieve the TMDL reduction, a complimentary best management practice system is needed; with cover crops providing plant residue cover following fall harvest and residue management (no-till or minimum till leaving 30% or more residue) providing an incentive for farmers to preserve that residue over winter and through planting in spring in order to better enhance water quality and promote soil health. Currently ATCP 50.68(3) (cover crop) (referenced in NR154 (9) (b)) states that a county may not, without prior department approval, provide cost-share under this section and ATCP 50.82(residue management) for the same acreage for in the same year. If a farmer were to enroll in this system, in the second year of the system the farmer will have received a residue management cost share payment in the spring and cover crop cost share payment after planting a cover crop following fall harvest of the commodity crop. Outagamie and Brown County are currently seeking approval to be able to provide funding for these practices in the same year in conjunction with another. This system of cover crops and residue management provides a greater reduction than just implementing cover crops that are tilled in the spring leaving little residue in spring months. SnapPlus[9] was run on three different fields in the Plum and Kankapot watershed comparing current tillage practices to residue management only, cover crop only, and cover crop and residue management. The system of using cover crops and maintaining residue showed the greatest sediment and phosphorus reductions (Appendix H).

[9] Snap (Soil Nutrient Application Planner) Plus is Wisconsin's nutrient management software that calculates potential soil and phosphorus losses on a field basis while assisting in the economic planning of manure and fertilizer applications. Additional information can be found on the website http://snapplus.wisc.edu/ .

Table 20. Management Measures Implementation Plan Matrix.

10 Year Management Measures Plan Matrix							
Recommendations	*Indicators*	*Milestones*			*Timeline*	*Funding Sources*	*Implementation*
		0-3 years	*3-7 years*	*7-10 years*			
1) Management Objective: Reduce the amount of sediment and phosphorus loading from agricultural fields and uplands.							
a) Application of conservation practices to cropland. These practices include[1]: • Increase acreage of conservation tillage (No till, Strip till, Mulch Till) in watershed area. Fields must meet 30% residue. • Implement use of cover crops • Enforcement of NR151.03 standard for tillage setback from surface waters where necessary. • Use of low disturbance manure injection on fields with cover crops & reduced tillage. • Prescribed grazing	# acres cropland with conservation practices applied	2,650	6,625	3,975	0-10 years	EQIP, TRM, GLRI, CSP, AM, WQT, MDV	NRCS, LCD
b) Installation of grassed waterways in priority areas.	# of linear feet of grassed waterways installed	12,540	31,350	18,810	0-10 years	EQIP, CREP, AM, WQT, MDV	NRCS, LCD

10 Year Management Measures Plan Matrix							
Recommendations	*Indicators*	*Milestones*			*Timeline*	*Funding Sources*	*Implementation*
		0-3 years	*3-7 years*	*7-10 years*			
c) Concentrated flow path seedings of cover that can be planted through.	# acres of concentrated flow area seedings	8	20	12	0-10 years	GLRI, EQIP, MDV	NRCS, LCD
d) Installation of vegetative buffers along perennial and intermittent streams and legal drains.	# acres of buffers installed	40	100	60	0-10 years	CREP/CRP, EQIP, GLRI, AM, WQT, MDV	NRCS, LCD
e) Nutrient Management: Sign up remaining landowners for nutrient management.	# of landowners signed up for nutrient management plans	4	6	3	0-10 years	EQIP, TRM, SEG, AM, WQT, MDV	NRCS, LCD
f) Checks to make sure installed practices and management plans are being maintained and properly followed.	# of farms checked	15	20	15	0-10 years	N/A	LCD
g) Enforcement of NR 151.03 standard for tillage setback from surface waters where necessary	% of fields meeting standard tillage setback	25%	50%	100%	0-10 years	N/A	LCD
h) Construct treatment wetlands to treat and store water from agriculture runoff and tile drainage	# of treatment wetlands installed	–	2	1	0-10 years	GLRI, AM, WQT, MDV	Nature Conservancy, NRCS, LCD

10 Year Management Measures Plan Matrix							
Recommendations	*Indicators*	*Milestones*			*Timeline*	*Funding Sources*	*Implementation*
		0-3 years	*3-7 years*	*7-10 years*			
i) Use of new technologies and innovative practices to reduce phosphorus and sediment loading from cropland. (Examples include: phosphorus removal structures, saturated buffers, soil amendment applications, interseeding cover crops)	# sites where new technologies have been used and assessed for effectiveness and feasibility	0	2	1	0-10 years	GLRI, NRCS, Other Federal/State/Private funding	LCD,NRCS
2) Management Objective: Slow the flow of runoff from upland areas to watershed streams							
a) Increase water storage by restoring wetlands.	# of acres of wetlands restored	0	9	8	0-10 years	EQIP, CREP/CRP, WQT, AM, MDV	NRCS, LCD
b) Install Water and Sediment Control basins to store and slow flow of runoff.	# of WASCOBS installed	0	9	8	0-10 years	EQIP, AM, WQT, GLRI,TRM, MDV	NRCS, LCD
c) Increase soil infiltration by implementing practices (a-i) under Management Objective 1.	–	–	–	–	–	–	–

10 Year Management Measures Plan Matrix							
Recommendations	*Indicators*	*Milestones*			*Timeline*	*Funding Sources*	*Implementation*
		0-3 years	*3-7 years*	*7-10 years*			
3) Management Objective: Reduce phosphorus runoff from barnyards							
a) Retrofit barnyard sites with necessary runoff control structures (gutters, filter strips, settling basins, clean water diversions)	# of barnyard sites addressed and retrofitted with necessary runoff control measures	1	2	0	0-7 years	EQIP, AM, WQT, TRM, MDV	NRCS, LCD
b) Manure management on livestock operation sites.	# of new or updated manure storage facilities	1	1	0	0-7 years	EQIP, AM, WQT, TRM, MDV	NRCS, LCD
4) Management Objective: Restore and stabilize degraded streambanks.							
a) Restore eroded stream banks by use of rip rap and/or biostabilization	# of linear feet of streambank stabilized	1,770	4,430	2,655	0-10 years	EQIP, GLRI, WQT, TRM, AM, MDV	NRCS, LCD, WDNR
b) Install streambank crossings to prevent further degradation	# of stream crossings installed	1	2	0	0-7 years	EQIP, TRM, MDV	NRCS, LCD, WDNR

1. A combination of the listed practices will be applied to agricultural fields to get the desired reductions required by the TMDL. Not all practices listed will be applied to each field. The combinations of practices applied will vary by field. In most cases just applying one practice to a field will not get desired reductions and a combination of 2-3 practices will be necessary to get desired reductions. See Appendix C.

9.0 Load Reductions

Load reductions for agricultural best management practices were estimated using STEPL (Spreadsheet Tool for Estimating Pollutant Loading) and load reductions from barnyards were estimated using the BARNY model. Percent reduction was based on the STEPL model agricultural, including streambank erosion, baseline loading of 26,601 lbs TP/yr and 5,490.4 tons TSS/year. The Lower Fox River TMDL calls for 56.1 % reduction of TSS and 78.6% reduction of TP from agriculture in the Apple Creek Watershed. An estimated 70 % reduction in TP and 62 % reduction in TSS are expected for planned management measures in the Apple Creek watershed. Expected load reductions from planned activities are shown in Table 21.

These estimated reductions show that the TMDL suspended sediment reduction goal is likely to be achieved but phosphorus reductions fall just short of the TMDL goal. The use of additional innovative practices and technologies will likely be needed to achieve the TMDL goal. See Appendix F for strategy to achieve the phosphorus reduction needed.

A challenge that presents itself in achieving TMDL reductions is legacy phosphorus in the soil and in stream. In recent years scientists and watershed managers are finding that water quality is not responding as well as expected to implemented conservation practices (Sharpley et al 2013). They are attributing this slower and smaller response to legacy phosphorus. Legacy phosphorus is used to describe the accumulated phosphorus that can serve as a long- term source of P to surface waters. Legacy phosphorus in a soil occurs when phosphorus in soils builds up much more rapidly than the decline due to crop uptake. In stream channels, legacy phosphorus can result from sediment deposition of particulate phosphorus, sorption of dissolved phosphorus onto riverbed sediments or suspended sediments, or by incorporation into the water column (Sharpley et al 2013). Therefore, water quality may not respond to implementation of conservation practices in a watershed as quickly as expected due to remobilization of legacy phosphorus hot spots.

Table 21. Expected load reductions from recommended best management practices.

Management Measure Category	Total Units (size/length)	Total Cost	Estimated Load Reduction			
			TP (lbs/yr)	Percent	TSS (t/yr)	Percent
Vegetative Riparian Buffers	200 acres	800,000.00	2,711.0	10.2	209.0	3.8
Streambank Restoration	8,855 ft	324,925.00	353.0	1.3	599.0	10.9
Barnyard Retrofits *(filter strips, waste storage, clean water diversions, maintenance/repair of existing practices, etc)*	4 Sites	155,260.00	171.0	0.6	NA	NA
Practices applied to Cropland *(Conservation Tillage/Residue Management,Cover Crops, Nutrient Management, Low Disturbance Manure Injection, Prescribed Grazing)* [1]	13,250 acres	3,239,000.00	14,513.7	54.5	1,668.8	30.4
Gully Stabilization *(Grassed Waterways, Concentrated Flow Area Seedings,Lined Waterway, WASCOBs,etc)*	137,541 ft/15 WASCOBs	423,905.00	547.2	2.1	880.4	16.0
Use of new technologies/equipment and innovative practices to reduce phosphorus and sediment loading from cropland *(Instream treatment in drainage ditches, saturated buffers, water control stuctures for tile outlets, phosphorus removal structures, soil amendment applications,etc)* [2]	unkown	unkown	NA	NA	NA	NA
Constructed Treatment Wetlands	3 sites	45,000.00	54.3	0.2	7.5	0.1
Wetland Restoration	15 acres	150,000.00	263.8	1.0	36.4	0.7
	Total	**5,138,090.00**	**18,614.0**	**70.0**	**3,401.1**	**62.0**

1. *This category <u>does not</u> indicate that all these practices will be applied to all 13,250 acres of cropland. A combination of conservation practices applied to a majority of the cropland in the watershed is necessary to get the desired pollutant load reductions suggested by the TMDL. It is also important to note that not all fields will need to apply more than one practice to meet desired reduction goals. The BMP Efficiency Calculator was used to determined efficiencies of different combinations of practices such as Reduced Tillage & Cover Crops or the use of a Nutrient Management and Reduced Tillage. A weighted average pollutant reduction efficiency was determined for this category based on expected implementation rates of combinations of practices. See Appendix D.*
2. *The amount of new technologies and management measures needed has not been determined, as well as, expected load reductions and cost. If new management measures/technologies prove effective and feasible they will be incorporated into the plan with more accurate load reductions, cost, and amount needed. Depending on the efficiencies realized by new innovative practices, the number or combinations of other field practices required may be reduced.*

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10.0 Information and Education

This information and education plan is designed to increase participation in conservation programs and implementation of conservation practices by informing the landowners of assistance and tools available to them and providing information on linkages between land management and downstream effects on water quality.

10.1 Alliance for the Great Lakes Survey

The Alliance for the Great Lakes developed an interview and questionnaire that was given to landowners in the Lower Fox River Watershed area in Spring and Summer of 2014 by County Land and Water Conservation Departments and local agronomists. Data from the questionnaires and interviews was analyzed by subwatershed. The survey and questionnaire gathered information on the knowledge of conservation and water quality issues, willingness to participate in conservation programs, and where landowners obtain their information. Moreover, many landowners of all farm sizes did not recognize the severity of water quality issues impacting the Lower Fox River Basin and the extent to which agricultural sources contribute to nutrient and sediment loadings to the River and the Bay of Green Bay. Providing information on available conservation programs, technical assistance, and education will be a very critical component of implementing the management plan.

<u>Selected Results from Survey</u>

Knowledge and Thoughts on Current Conservation Programs:

One of the interview questions asked respondents to reflect on the conservation programs currently being offered. The responses were organized by themes and further by subwatersheds to gain a better understanding of what landowners think about conservation programs and whether responses differ across different areas of the Lower Fox River watershed. A total of 28 themes were identified (ranging from “Willing to try them” to “More exist than necessary”) with the most frequently mentioned theme being “Not familiar with programs” as shown in Figure 40 below. When broken down by subwatersheds the most frequently mentioned theme varied by subwatershed. For comparison, among respondents in Duck/Trout Creeks subwatershed most frequently mentioned theme was “involved in them”, in Apple/Ashwaubenon/Dutchman Creeks, it was “going well-good programs”, in East River/Baird/Bower Creeks, both “involved in them” and going well-good programs” were both at the top of the list, and in Plum/Kankapot Creeks it was “Not familiar with programs”. The subwatersheds that responded with “involved in them” and “going well-good programs” are subwatersheds that have previously been part of a priority watershed project or have previously been focused on for conservation efforts.

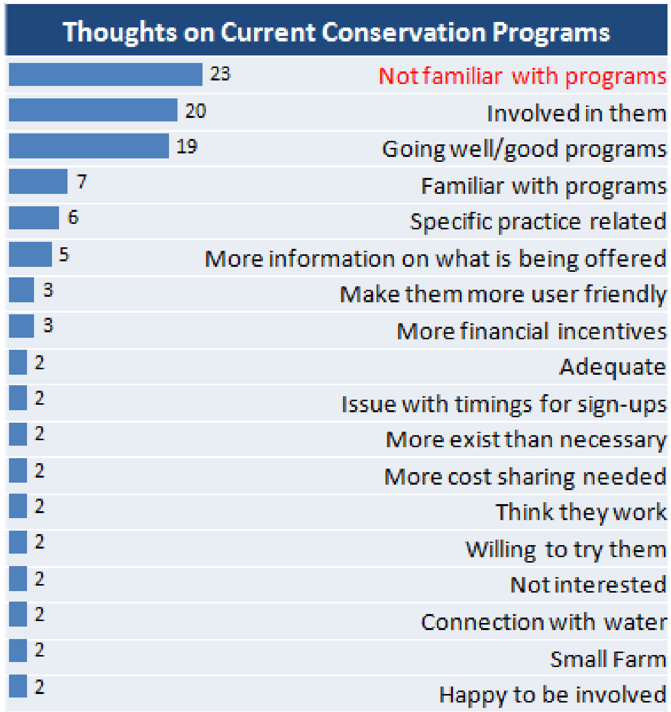

Figure 40. Survey results on Thoughts on Current Conservation Programs in all subwatersheds. (Alliance for the Great Lakes)

Information/Communication:

A number of the questions in the interview and questionnaire were designed to get a better understanding regarding what organizations or entities landowners go to for information and how they prefer to receive/exchange information. The results listed below reflect some of the responses most relevant to this plan:

1. Many respondents want to see the County Land and Water Conservation Departments conduct more education and provide information on practices.
2. 83% Moderately to very interested in demonstration farms as information sources in the Apple/Ashwaubenon/Dutchman Creeks subwatershed.
3. 72% Moderately to very interested in sharing information in a group setting in the Apple/Ashwaubenon/Dutchman Creek subwatershed.
4. The preferred methods of communication were: newsletters, on farm demonstrations/field days, one on one hands on demonstrations, and magazines (based on responses from the entire Lower Fox River watershed).
5. Landowners go to similar organizations for both farming advice and water quality information (% indicates the percentage of respondents who named this organization as important).

a. For agronomic information in Apple/Ashwaubenon/Dutchman Creeks watersheds, these include: Local Farm Cooperatives/Crop Consultants (83%); Other Farmers (83%); NRCS (58%); County Land and Water Conservation Department (75%); University of Wisconsin-Extension (58%)
b. For water quality information in Apple/Ashwaubenon/Dutchman Creeks watersheds, these include: Local Farm Cooperatives/Crop Consultants (90%); County Land and Water Conservation Department (100%); NRCS (90%); Farmer Led Watershed Organization (90%); Farm Service Agency (80%)

Severity of sources of pollution in your area:

The survey asked several questions related to water quality in the Lower Fox River watershed and Green Bay, specifically on impacts, particular pollutants, and sources of the pollutants. Overall, consequences of poor water quality in the area were mostly rated as slight to moderate problems. Similarly, among the sources listed, most were perceived to be slightly or moderately problematic. Notably:

- Respondents perceived the most serious source of water pollution coming from non-agricultural sources.
    - 65 % identified “excessive use of lawn fertilizers and pesticides” as a moderate to severe problem
    - Next three most problematic pollutant sources were storm water runoff from urban areas, discharges from sewage treatment plants, and discharges from industry.
- Of the six agricultural pollution sources, the one perceived as most severe was “soil erosion from fields” with 37% followed by “land application of animal waste” with 19%. By comparison, 31% identified waterfowl droppings as a moderate to severe problem.

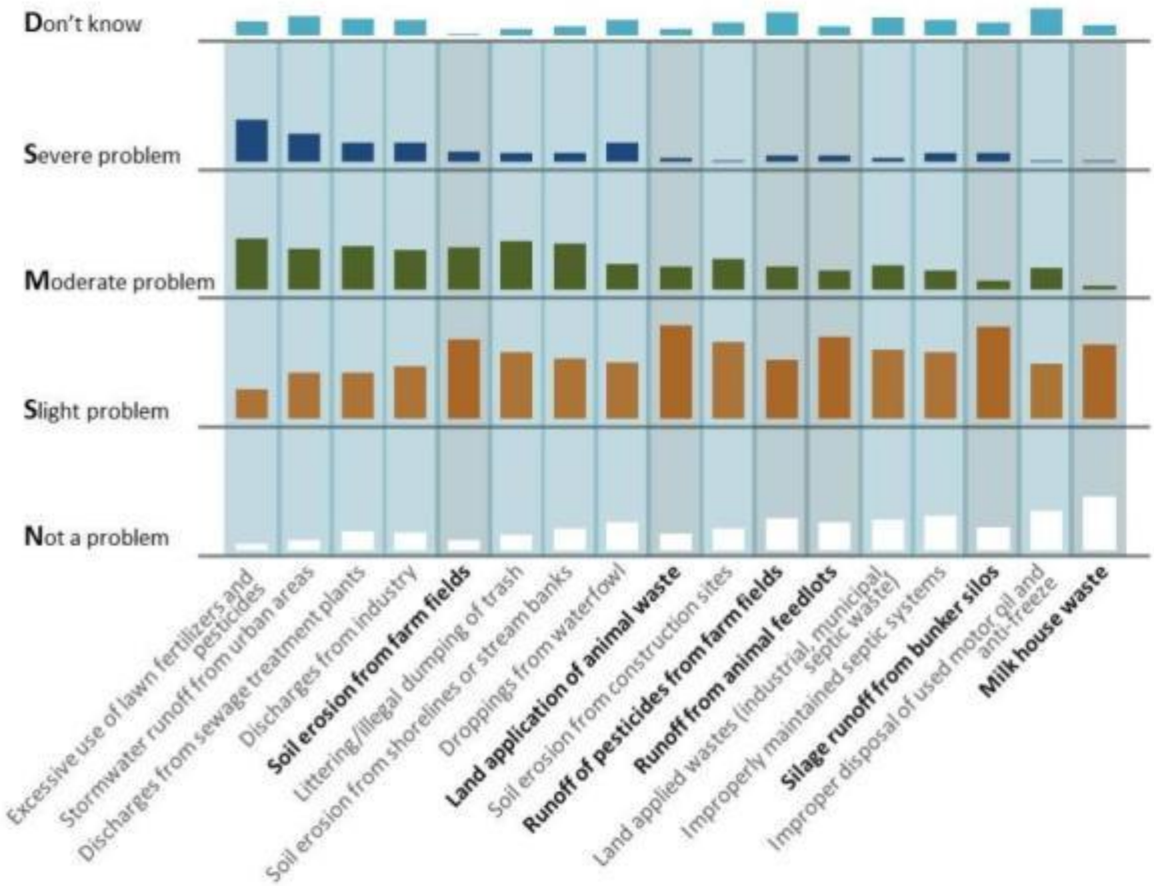

Figure 41. Survey responses to severity of sources of pollution in the Lower Fox River and Bay of Green Bay. (Alliance for the Great Lakes)

10.2 Recommended Information and Education Campaigns

Goals for the Information and education plan and recommended actions were based on the results from the survey. An effective Information and Education Plan includes the following components as referenced in USEPA's "*Handbook for Developing Watershed Plans to Restore and Protect our Waters*" (USEPA 2008):

- Define I&E goals and objectives
- Identify and analyze the target audiences
- Create the messages for each audience
- Package the message to various audiences
- Distribute the message
- Evaluate the I&E program

Goals of the information and education plan: Create public awareness of water quality issues in the watershed, increase public involvement in watershed stewardship, and increase communication and coordination among municipal officials, businesses, and agricultural community.

Objectives

- Educate local officials about the watershed plan. Encourage amendments to municipal comprehensive plans, codes, and ordinances.
- Develop targeted educational materials to appropriate audience in the watershed.
- Host workshops, meetings, and events that landowners can attend to learn about conservation practices.
- Increase landowners' adoption of conservation practices.
- Inform public of current water quality issues in the Lower Fox River Watershed basin and how the Apple Creek watershed contributes.
- Get local high schools and colleges involved in watershed activities.

Target Audience

There are multiple target audiences that will need to be addressed in this watershed. Target audiences in this watershed will be agricultural land owners and operators, local government officials, agricultural businesses and organizations, urban home owners, and schools. Focused attention will be on agricultural land owners and operators since the main source of pollutant loading in the watershed is from agricultural land. Non-operator agricultural landowners are an important subset of this group as they are usually not focused on and are less likely to participate in conservation programs. The 1999 Agricultural Economics and Land Ownership survey showed that 34 % of farmland in Wisconsin was owned by non-operator landlords (USDA NASS 1999). Studies have shown that non-operators tend to be older, less likely to live on the farm, and less likely to participate in conservation programs (Nickerson et al 2012). Non-operator land owners in the watershed area need to be addressed as they control a significant amount of agricultural land but tend to leave the management of the land up to the tenant.

Existing Education Campaigns:

Fox- Wolf Watershed Alliance (FWWA): A nonprofit organization that identifies issues and advocates effective policies and actions to protect and restore the water resources of Wisconsin's Fox-Wolf River watershed. They hold events such as river clean-ups, workshops, presentations at Annual Watershed Conferences, and meetings with other organizations to outreach to the public. Fox- Wolf Watershed Alliance works with local organizations to produce two newsletters "The Source" and "Basin Buzz" to inform and update the public on current projects, programs, funding, and research in the Fox- Wolf Basin. "The Source" is an online newsletter distributed by email whose target audience is the general public and the "Basin Buzz" is a newsletter distributed by mail that's geared toward agricultural land owners in the Lower Fox Basin. Current and previous issues of both newsletters can be found on the FWWA website. For more information go to http://fwwa.org/.

Northeast Wisconsin Stormwater Consortium (NEWSC): A subsidiary of the Fox-Wolf Watershed Alliance composed of municipal members and business partners working to address storm water issues and to educate residents on best management practices, ordinances and other storm water concerns and programs.

Lower Fox Demonstration Farms Network: Currently there is a demonstration farm project with four established demonstration farms in the Lower Fox River Watershed. The network is currently planning on expanding the network to include two additional farms in the watershed. The goal of the demonstration farms network is to test new conservation methods and to educate other farmers. The demonstration farm network holds field days for local farmers and agency members to learn about the different practices being tested. For more information go to https://www.facebook.com/FoxDemoFarms/ .

Silver Creek Adaptive Management Project: NEW Water formerly, Green Bay Metropolitan Sewerage District, is working on a phosphorus reduction plan to reduce its discharges to the Fox River. NEW Water is implementing a pilot adaptive management project in the Silver Creek Subwatershed.

I&E Plan Recommended Actions

An Information and Education Plan matrix (Table 22) was developed as a tool to help implement the I&E plan. The matrix includes recommended action campaigns, target audience, package for delivery of message, schedule, outcomes, estimated costs, and supporting organizations.

Evaluation

The I&E plan should be evaluated regularly to provide feedback regarding the effectiveness of the outreach campaigns. Section 13.3 describes milestones related to watershed education activities that can be used to evaluate I&E plan implementation efforts.

Table 22. Information and Education Plan Implementation Matrix.

Information and Education Plan Implementation Matrix						
Information and Education Action	**Target Audience**	**Recommendations**	**Schedule**	**Outcomes**	**Cost**	**Implementation**
Inform the public on watershed project.	General Public	• Completed plan posted on county website. • Present plan to public at a public meeting. • Create a web page (Facebook, page on County website) for watershed project. • Develop exhibits for use at libraries, government offices, and local events (County Fairs and Farm Shows).	0-3 years	General public is aware of watershed implementation plan and has better understanding of how they can impact water quality.	$1,200	LCD, Fox Wolf Watershed Alliance
Educate landowners on watershed project and progress.	Private landowners, agricultural landowners/ operators	Bi-annual/annual newsletter ("Basin Buzz"/ "The Source") including watershed updates as well as information on new practices and programs.	0-10 years	Landowners are informed on project and progress. Landowners can stay up to date on new practices and strategies available.	$7,000	LCD, Fox Wolf Watershed Alliance

Information and Education Plan Implementation Matrix						
Information and Education Action	**Target Audience**	**Recommendations**	**Schedule**	**Outcomes**	**Cost**	**Implementation**
Educate agricultural landowners and operators about the plan, its recommendation actions, and technical assistance and funding available.	Agricultural landowners/ operators	• Distribute educational materials on conservation practices and programs. • One on one contact with individual landowners to provide tools and resources. • Orchestrate group meetings with agricultural landowners in watershed to share knowledge and foster community connections for long term solutions. • Offer workshops to agricultural landowners to educate them on conservation practices that should be used to preserve the land and protect water resources. • Tour local demonstration farms and other sites that have implemented conservation practices.	0-10 years	• Agricultural landowners are informed about conservation practices, cost share programs, and technical assistance available to them. • Increase in interest in utilizing and installing conservation practices. • Improved communication between agricultural landowners, willingness to share ideas, and learn from other agricultural landowners. • Agricultural landowners recognize the benefit of conservation farming practices and how it improves water quality. • Agricultural landowners see success of conservation practices as well as problems that can be expected.	$15,000	LCD,NRCS,UWEX

Information and Education Plan Implementation Matrix						
Information and Education Action	**Target Audience**	**Recommendations**	**Schedule**	**Outcomes**	**Cost**	**Implementation**
Reach out to non-operator land owners.	Non-operator agricultural landowners	• Distribute educational materials targeted to non-operator agricultural landowners. • One on one contact and group meetings with non-operator agricultural land owners to share knowledge and foster community connections for long term solutions. • Hold workshop for non-operator land owners.	0-5 years	Non-operator landowners are informed on conservation practices. Increased participation rates in conservation activities from non-operator land owners.	$3,500	LCD, NRCS, UWEX
Educate local officials about the completed plan. Encourage amendments of municipal comprehensive plans, codes, and ordinances to include watershed plan goals and objectives.	Elected officials in Outagamie County, Brown County, City of Appleton, City of Kaukauna, Town of Little Chute, Town of Grand Chute, Town of Kaukauna, Town of Vandenbroek, Town of Freedom and Town of Lawrence.	Present project plan to officials and conduct meetings with government officials.	0-3 years	Local municipalities adopt plan and amend ordinances, codes, and plans to include watershed plan goals and objectives.	No cost using existing resources.	LWCD

Information and Education Plan Implementation Matrix						
Information and Education Action	**Target Audience**	**Recommendations**	**Schedule**	**Outcomes**	**Cost**	**Implementation**
Educate homeowners on actions they can take to reduce polluted runoff from their yards.	Homeowners	Distribute educational materials to homeowners on how to reduce polluted stormwater runoff from their yards.	0-5 years	Homeowners are aware of the impact they can have on water quality and actions they can take to reduce pollutions from their yards.	$1,000	UWEX, LCD, Fox Wolf Watershed Alliance
Educate local agricultural businesses and organizations on objectives of watershed project.	Agronomists, Co-ops, Seed dealers	Meetings with local agricultural organizations to share goals of project and planned conservation practices and outreach needed.	0-3 years	Local agricultural organizations are aware of watershed project and can assist landowners with conservation needs as well as help deliver common message to protect water quality in watershed area.	$1,500	UWEX, LCD
Outcome of information and education plan.	Agricultural landowners/ operators	Survey agricultural landowners on water quality awareness, knowledge of conservation practices, and participation on conservation practices.	7-10 years	Increased awareness of water quality and conservation practices in the watershed area in comparison to 2014 survey.	$3,000	LCD, UWEX

11.0 Cost Analysis

Cost estimates were based on current cost-share rates, incentives payments to get necessary participation, and current conservation project installation rates. Current conservation project installation rates were obtained through conversations with county conservation technicians. Landowners will be responsible for maintenance costs associated with installed practices. The total cost to implement the watershed plan is estimated to be $7,254,247 with an additional 2 million in new technology costs.

Summary of Cost Analysis

- $5,138,090 to implement best management practices.
- $1,772,708 needed for technical assistance.
- $123,449 needed for information and education.
- $220,000 for water quality monitoring.
- $2 million for new innovative practices.

Table 23. Cost estimates for implementation of best management practices.

BMP	Quantity	Cost /Unit ($)	Total Cost ($)
Upland Control			
Conservation Tillage (ac)[1]	11,000	18.50	610,500
Cover Crops (ac)[1]	11,100	70.00	2,331,000
Grass Waterways (ln ft)	62,701	5.00	313,505
Concentrated Flow Area Seeding (ac)	40	135.00	5,400
Vegetative Buffers (ac)	200	4,000.00	800,000
Nutrient Mgmt (ac)[2]	2,900	10.00	116,000
Wetland Restoration (ac)	15	10,000.00	150,000
Treatment Wetlands (sites)	3	15,000.00	45,000
Water and Sediment Control Basin (ea)	15	7,000.00	105,000
Low Disturbance Manure Injection (ac)	3,000	58.00	174,000
Prescribed Grazing (ac)	150	50.00	7,500
Barnyard Runoff Control			
Filter Strip/ Wall (ea)	3	25,000.00	75,000
Roof Runoff Structure (ln ft)	200	12.00	2,400

BMP	Quantity	Cost /Unit ($)	Total Cost ($)
Clean Water Diversion (ea)	1	3,000.00	3,000
Waste Storage (ea)	1	70,000.00	70,000
Milkhouse Waste Treatment (ea)	1	4,860.00	4,860
Streambank Erosion Control			
Streambank Restoration (ln ft)	8,855	35.00	309,925
Crossing (ea)	3	5,000.00	15,000
Technical Assistance			
Conservation/Project Technician[3]	1	78,000.00	894,183
Agronomist[3]	1	66,000.00	878,525

1.Cost based on cost sharing for 3 year time period. These practices become an option during the corn silage years of a typical dairy rotation as well as anytime in a cash grain rotation. Within the 10-years of this plan implementation, it is assumed that all dairy rotation land will have a 3-yr window to implement these soil health strategies.

2.Cost based on cost sharing for 4 year time period.

3.Cost based on employment for 10 years including benefits and 3% increase per year for salary and fringe costs.

Table 24. Information and Education Costs.

Information and Education	Cost
Staff hours (2,600 hours of staff time for 5 years)	91,249
Materials (Postage, printing costs, paper costs, and other presentation materials)	32,200

Table 25. Water Quality Monitoring Costs.

Water Quality Monitoring Activity	Cost($)
USGS Automated Monitoring Station (Equipment & Installation)	20,000
Subcontract and lab analysis cost USGS automated station (10 years of monitoring)	200,000
Total	**220,000**

Estimated Costs of new/alternative practices:

Cost of new technologies/management methods was not included in this estimate since the quantity of these technologies that may be needed is not yet known. Approximate costs for a selected few new technologies are as follows:

- $25-45/ton gypsum. Typical application rate to improve soil physical properties, water infiltration/percolation, and water quality is 1,000-9,000 lbs/acre (Chen et al 2011).
- Drainage water management structure for tile drains: $500-$2,000 each unit or $20-$110/acre.
- Cost of a P- removal structure varies depending on site characteristics, target removal, phosphorus sorbing material characteristics. Oklahoma State University found that the total cost of P removal can be $30-100 per lb of P removed. The NRCS recently developed a national standard for phosphorus removal structures (Code 782), so that construction of P removal structures may be cost shared.
- STRIPS- $24-$35/acre- Can be cost shared through CRP.

The proposed "Pay for Performance" system would cost share landowners twice a year based on cover crop growth and percent of spring and fall residue. This system will incentivize landowners to reduce tillage and plant cover crops as a system on their fields, thereby reducing soil erosion, increasing infiltration rates of soils and providing healthier soils. The proposed payment schedule is as follows:

<u>Fall</u>
Cover Crop: $7 per acre for 10% cover crop cover (up to 60% cover), maximum payment of $42
No-till: $9/acre payment

<u>Spring</u>
Cover Crop: $3 per acre/10% cover crop cover (up to 60%) maximum payment of $18
No-till: $9/acre payment

Total yearly payment range: $3/acre-$78/acre

Operation & Maintenance

This plan will require a land owner to agree to a 10 year maintenance period for practices such as vegetated buffers, grassed waterways, water and sediment control basins, treatment wetlands, wetland restoration, barnyard runoff control, manure storage, and streambank stabilization including crossings and fencing. For annual practices that require re-installation of management each year such as conservation tillage, cover crops, and nutrient management, landowners are required to maintain the practice for each period that cost sharing is available. Therefore annual assistance may be required for certain practices. Upon completion of the operation and maintenance period, point sources may be able to work with operators and landowners to continue implementation of the BMP's under a pollutant trading agreement (non EPA 319 monies).

12.0 Funding Sources

There are many state and federal programs that currently provide funding sources for conservation practices. Recently the option of adaptive management, water quality trading, and phosphorus variance has become another option for funding of practices.

12.1 Federal and State Funding Sources

A brief description of current funding programs available and their acronyms are listed below:

Environmental Quality Incentives Program (EQIP) - Program provides financial and technical assistance to implement conservation practices that address resource concerns. Farmers receive flat rate payments for installing and implementing runoff management practices.

Conservation Reserve Program (CRP) - A land conservation program administered by the Farm Service Agency. Farmers enrolled in the program receive a yearly rental payment for environmentally sensitive land that they agree to remove from production. Contracts are 10-15 years in length. Eligible practices include buffers for wildlife habitat, wetlands buffer, riparian buffer, wetland restoration, filter strips, grass waterways, shelter belts, living snow fences, contour grass strips, and shallow water areas for wildlife.

Conservation Reserve Enhancement Program (CREP) - Program provides funding for the installation, rental payments, and an installation incentive. A 15 year contract or perpetual contract conservation easement can be entered into. Eligible practices include filter strips, buffer strips, wetland restoration, tall grass prairie and oak savanna restoration, grassed waterway, and permanent native grasses.

ACEP- Agricultural Conservation Easement Program - New program that consolidates three former programs (Wetlands Reserve Program, Grassland Reserve Program, and Farm and Ranchlands Protection Program). Under this program NRCS provides financial assistance to eligible partners for purchasing Agricultural Land Easements that protect the agriculture use and conservation values of eligible land.

Targeted Runoff Management Grant Program (TRM) - Program offers competitive grants for local governments for controlling nonpoint source pollution. Grants reimburse costs for agriculture or urban runoff management practices in critical areas with surface or groundwater quality concerns. The cost-share rate for TRM projects is up to 70% of eligible costs.

Conservation Stewardship Program (CSP) – Program offers funding for participants that take additional steps to improve resource condition. Program provides two types of funding through 5 year contracts; annual payments for installing new practices and maintaining existing practices as well as supplemental payments for adopting a resource conserving crop rotation.

Great Lakes Restoration Initiative (GLRI) - Program is the largest funding program investing in the Great Lakes. Currently the Lower Fox River watershed is one of three priority watersheds in the Great Lakes Restoration Initiative Action Plan. Under the initiative nonfederal governmental entities (state agencies, interstate agencies, local governments, non- profits, universities, and federally recognized Indian tribes) can apply for funding for projects related to restoring the Great Lakes.

Farmable Wetlands Program (FWP) - Program designed to restore previously farmed wetlands and wetland buffer to improve both vegetation and water flow. The Farm Service Agency runs the program through the Conservation Reserve Program with assistance from other government agencies and local conservation groups.

Land Trusts- Landowners also have the option of working with a land trust to preserve land. Land trusts preserve private land through conservation easements, purchase land from owners, and accept donated land.

12.2 Adaptive Management and Water Quality Trading

Adaptive management and water quality trading are potential sources of funding in this watershed if there are interested point sources. Adaptive management and water quality trading can be easily confused. Adaptive management and water quality trading can provide a more economically feasible option for point source dischargers to meet their waste load allocation limits. Point sources provide funding for best management practices to be applied in a watershed and receive credit for the reduction from that practice. Adaptive management focuses on compliance with phosphorus criteria while water quality trading focuses on compliance with a discharge limit.

Table 26. Comparison of Adaptive Management and Water Quality Trading.

Adaptive Management	Water Quality Trading
Receiving water is exceeding phosphorous loading criteria.	The end of pipe discharge is exceeding the allowable limit.
More flexible and adaptive to allow cropland practices to show reductions over extended time period.	Not as flexible, needs to show stable reductions year to year.
Does not use "trade ratios" as modeling factor.	Uses "trade ratios" as margin of error factor.
Uses stream monitoring to show compliance.	Uses models such as SNAP+ or BARNY to show compliance with reduction in loading.
Typically used for phosphorus compliance only.	Can be used for a variety of pollutants, not just phosphorus.
Can be used to quantify phosphorus reductions for up to 15 years.	Can be used to demonstrate compliance indefinitely as long as credits are generated.
Wetland restoration, bank stabilization, and other similar practices can count towards compliance.	Wetland restoration, bank stabilization, and other similar practices can count towards compliance if reductions are quantifiable.

12.3 Phosphorus Multi- Discharger Variance (MDV) (Wisconsin Act 378)

In April of 2014, Act 378 was enacted; this act required the Wisconsin Department of Administration in consultation with the Department of Natural Resources to determine if complying with phosphorus limits causes Wisconsin substantial and economic hardship. It was determined that costs associated with waste water treatment to remove phosphorus would cause a substantial and widespread economic impact on the state.

The DNR is working with the EPA to implement a Multi-discharger Phosphorus Variance to help point sources comply with phosphorus standards in a more economically viable way. A multi- discharger variance extends the timeline for complying with low level phosphorus limits. In exchange, point sources agree to step wise reduction of phosphorus within their effluent as well as helping to address nonpoint source of phosphorus from farm fields, cities or natural areas by paying $50 per pound to implement projects designed to improve water quality. A permittee that chooses to make payments for phosphorus reduction will make payments to each county that is participating in the program and has territory within the basin in which the point source is located in proportion to the amount of territory each county has within the basin. A county will then use the payments to provide cost sharing for projects to reduce the amount of phosphorus entering the waters of the state, for staff to implement phosphorus reduction projects, and/or for modeling or monitoring to evaluate the amount of phosphorus in the waters of the state for planning purposes. The final Multi-Discharger Variance package was submitted to the EPA on March 30, 2016 and approved by the EPA on February 6, 2017.

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13.0 Measuring Plan Progress and Success

Monitoring of plan progress will be an essential component of achieving the desired water quality goals. Plan progress and success will be tracked by water quality improvement, progress of best management practice implementation, and by participation rates in public awareness and education efforts.

13.1 Water Quality Monitoring

In order to measure the progress and effectiveness of the watershed plan, water quality monitoring will need to be conducted throughout the plan term. Physical, chemical, and biological data will need to be collected to see if the water quality is meeting TMDL standards and designated use standards. This plan calls for the continuation of current monitoring programs with additional monitoring recommendations.

<u>Stream Water Quality Monitoring</u>

Surface water samples are collected on a monthly basis from the mouth of the Apple Creek from May through October which began in 2015 as part of the Lower Fox River Monitoring program. On each sampling date, volunteers collect and ship surface water samples to the Wisconsin State Laboratory of Hygiene for the analysis of TP, TSS, and dissolved reactive phosphorus (DRP). Volunteers will also utilize transparency tubes to assess and document the transparency of each stream on each date. Macroinvertebrate sampling will also be performed by volunteers on Apple Creek during September or October and will be delivered to UW-Superior for identification to lowest taxonomic level on a periodic basis, currently proposed to be every 3-5 years. All sampling will be conducted in accordance with WDNR protocol. A summary of the Lower Fox River Monitoring Strategy is shown in Appendix E.

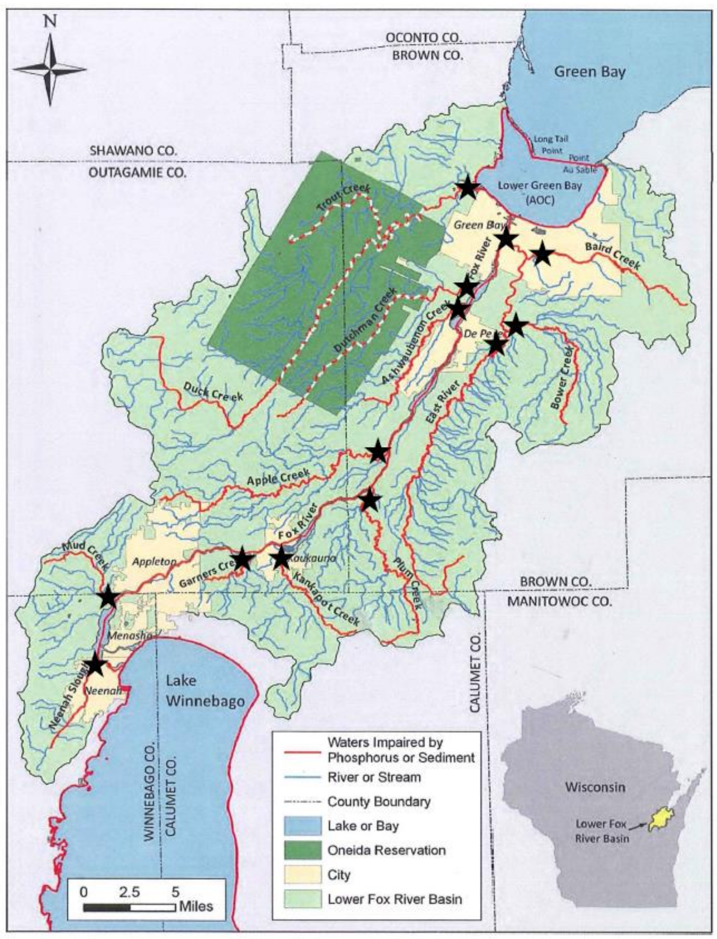

Figure 42. Approximate sample locations for the Lower Fox River Volunteer Monitoring.

To obtain more accurate data on water quality changes due to implementation of practices in the Apple Creek subwatershed an automated USGS continuous monitoring station near the mouth of Apple Creek is recommended. A continuous monitoring station near the mouth of Apple Creek would better show any changes in water quality from implementation of best management practices in the watershed.

USGS automated monitoring stations record precipitation, gage height, and discharge. Automated samplers installed at a continuous monitoring station also take water samples. This plan calls for low flow samples and event samples to be collected from the proposed site. As streamflow increases due to runoff events, automated samplers installed at the stations take water samples. Samples from monitoring stations will be collected weekly May- October and monthly for the remaining months. Samples will be analyzed for total phosphorus and total suspended solids. One- half of the low flow samples will be analyzed for dissolved phosphorus in addition to TP and TSS and approximately 25 event samples per site will be analyzed for dissolved phosphorus. All samples will be analyzed at a certified lab, and all data from the sites will be stored in the USGS National Information System (NWIS) data base.

13.2 Tracking of Progress and Success of Plan

Progress and success of the Apple Creek Watershed Project will be tracked by the following components:

1) Information and education activities and participation
2) Pollution reduction evaluation based on BMP’s installed
3) Water quality monitoring
4) Administrative review

Outagamie and Brown County Land Conservation Departments will be responsible for tracking progress of the plan. Land Conservation departments will need to work with NRCS staff to track progress and implement projects. Reports will be completed annually, and a final report will be prepared at the end of the project.

1) Information and education reports will include:
   a) Number of landowners/operators in the watershed plan area.
   b) Number of eligible landowners/operators in the watershed plan area.
   c) Number of landowners/operators contacted.
   d) Number of cost-share agreements signed.
   e) Number and type of information and education activities held, who lead the activity, how many invited, how many attended, and any measurable results of I&E activities.
   f) Number of informational flyers/brochures distributed per given time period.
   g) Number of one on one contacts made with landowners in the watershed.
   h) Comments or suggestions for future activities.

2) Installed best management practices will be mapped using GIS. Pollution reductions from completed projects will be evaluated using models and spreadsheet tools such as STEPL and SnapPlus for upland practices and the BARNY model for barnyard practices. The annual report will include:
   a) Planned and completed BMP’s.
   b) Pollutant load reductions and percent of goal planned and achieved.
   c) Cost-share funding source of planned and installed BMP’s.
   d) Numbers of checks to make sure management plans (nutrient management, grazing management) are being followed by landowners.
   e) Number of checks to make sure practices are being operated and maintained properly.
   f) The fields and practices selected and funded by a point source (adaptive management or water quality trading) compliance options will be carefully tracked to assure that Section 319 funds are not being used to implement practices that are part of a point source permit compliance strategy.
   g) Number of new and alternative technologies and management measures assessed for feasibility, used, and incorporated into plan.

3) Water Quality Monitoring Reporting Parameters:
   a) Annual summer median total phosphorus and total suspended solids concentrations and loading values from USGS stream monitoring stations.
   b) Annual mean discharge and peak flow discharge from USGS stream monitoring stations.
   c) Total phosphorus, dissolved reactive phosphorus, total suspended solids, and clarity data from volunteer grab sampling (Lower Fox River Watershed Monitoring Program).
   d) Edge of field monitoring results.
   e) Macroinvertebrate Index of Biotic Integrity.

4) Administrative Review tracking and reporting will include:
   a) Status of grants relating to project.
   b) Status of project administration including data management, staff training, and BMP monitoring.
   c) Status of nutrient management planning, and easement acquisition and development.
   d) Number of cost-share agreements.
   e) Total amount of money on cost-share agreements.
   f) Total amount of landowner reimbursements made.
   g) Staff salary and fringe benefits expenditures.
   h) Staff travel expenditures.
   i) Information and education expenditures.

j) Equipment, materials, and supply expenses.
k) Professional services and staff support costs.
l) Total expenditures for the county.
m) Total amount paid for installation of BMP's and amount encumbered for cost-share agreements.
n) Number of Water Quality Trading/Adaptive Management contracts.

Water Quality Indicators

Plan progress will also be measured by water quality data. Median summer phosphorus concentrations, annual phosphorus and suspended sediment loading rates, and macroinvertebrate index of biotic integrity values will be used to determine improvement in water quality. Water quality monitoring indicators for success are shown in Table 27.

Table 27. Water quality monitoring indicators for success.

Monitoring Recommendation	Indicators	Estimated Current Values	Target Value or Goal for Apple Creek Watershed	Short Term (3 yrs)	Medium Term (7 yrs)	Long Term (10 yrs)	Implementation	Funding
Apple Creek								
Monitoring Station at Mouth of Apple Creek	# lbs phosphorus/yr	32,333	12,557	28,378	18,490	12,557	USGS/UWGB	GLRI
	# tons total suspended sediment/yr	6,268	3,106	5,636	4,055	3,106		
Lower Fox River Surface Water Monitoring	% of sites with a Good IBI rating	Poor	Good	50%	75%	100%	WDNR	WDNR
Lower Fox River Surface Water Monitoring	Summer Median Total Phosphorus (mg/l)	0.30	0.075	0.26	0.14	0.075	WDNR	WDNR

13.3 Progress Evaluation

Due to the uncertainty of models and the efficiency of best management practices, an adaptive management approach should be taken with this subwatershed (Figure 43). Milestones are essential when determining if management measures are being implemented and how effective they are at achieving plan goals over given time periods. Plan milestones are based on the implementation schedule with short term (0-3 years), medium term (3-7 years), and long term (7-10 years) milestones. After the implementation of practices and monitoring of water quality, plan progress and success should be evaluated after each milestone period. In addition to the annual report an additional progress report should be completed at the end of each milestone period. The progress report will be used to identify and track plan implementation to ensure that progress is being made and to make corrections as necessary. Plan progress will be determined by minimum progress criteria for management practices, water quality monitoring, and information and education activities held. If lack of progress is demonstrated, factors resulting in milestones not being met should be included in the report. Adjustments should be made to the plan based on plan progress and any additional new data and/or watershed tools.

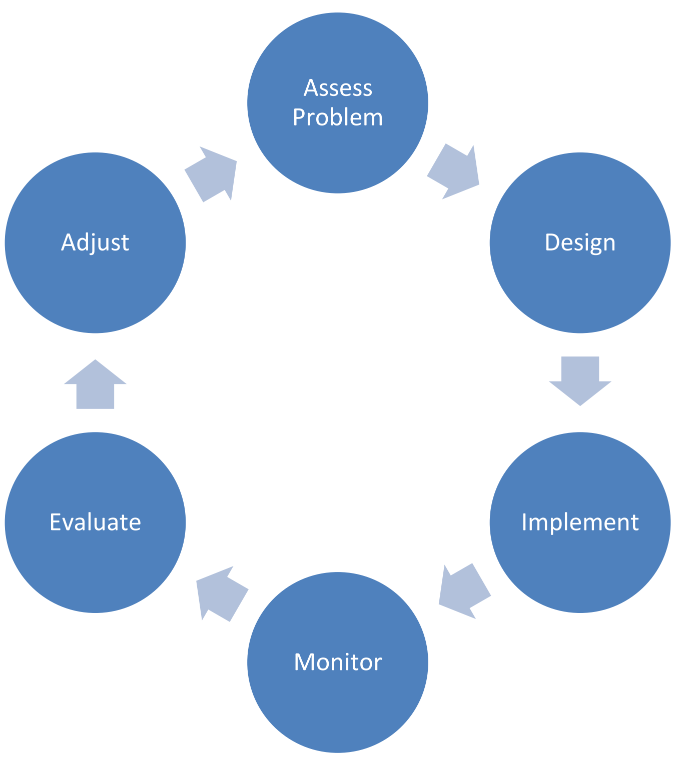

Figure 43. Adaptive Management Approach.

Water Quality Monitoring Progress Evaluation

This implementation plan recognizes that estimated pollutant load reductions and expected improvement in water quality or aquatic habitat may not occur immediately following implementation of practices due to several factors (described below) that will need to be taken into consideration when evaluating water quality data. These factors can affect or mask progress that plan implementation has made elsewhere. Consultation with the DNR and Water Quality biologists will be critical when evaluating water quality or aquatic habitat monitoring results. Milestones for pollutant load reductions are shown in Table 27. If the target values/goals for water quality improvement for the milestone period are not being achieved, the water quality targets or timetable for pollutant reduction will need to evaluated and adjusted as necessary.

The following criteria will be evaluated when water quality and aquatic habitat monitoring is completed after implementation of practices:

- Changes in land use or crop rotations within the same watershed where practices are implemented. (Increase in cattle numbers, corn silage acres, and/or urban areas can negatively impact stream quality and water quality efforts)
- Location in watershed where land use changes or crop rotations occur. (Where are these changes occurring in relation to implemented practices?)
- Watershed size, location where practices are implemented and location of monitoring sites.
- Climate, precipitation and soil conditions that occurred before and during monitoring periods. (Climate and weather patterns can significantly affect growing season, soil conditions, and water quality)
- Frequency and timing of monitoring.
- Percent of watershed area (acres) or facilities (number) meeting NR 151 performance standards and prohibitions.
- Percent of watershed area (acres) or facilities (number) that maintain implemented practices over time.
- Extent of gully erosion on crop fields within watershed over time. How many are maintained in perennial vegetation vs. plowed under each year?
- Stability of bank sediments and how much this sediment may be contributing P and TSS to the stream
- How “Legacy’ sediments already within the stream and watershed may be contributing P and sediment loads to stream?
- Presence and extent of drain tiles in watershed area in relation to monitoring locations. Do these drainage systems contribute significant P and sediment loads to receiving streams?
- Does monitored stream meet IBI and habitat criteria but does not meet TMDL water quality criteria?
- Are targets reasonable? Load reductions predicted by models could be overly optimistic.

Management Measures/Information and Education Implementation Progress Evaluation

Implementation milestones for management measures are shown in the 10 Year Management Measures Plan Matrix (Table 20) and milestones for Information and Education Plan implementation are shown in Table 28. If less than 70% of the implementation milestones are being met for each milestone period, the plan will need to be evaluated and revised to either change the milestone(s) or to implement projects or actions to achieve the milestone(s) that are not being met.

Table 28. Information and Education Plan Implementation Milestones

Information and Education Plan Implementation Goal Milestones
Short Term (0-3 years)
a) Completed watershed plan posted on county websites. b) Facebook/Website/or Page on county website developed for watershed information and updates. c) 1 exhibit displayed or used at local library, government office, and/or local event. d) Distribution of informational materials on watershed project and conservation practices to all eligible land owners. e) At least 30 one on one contacts made with agricultural landowners. f) At least 2 meetings held with agricultural landowners. g) At least 2 educational workshops/tours held at a demonstration farm. h) At least three issues of "Basin Buzz" newsletter distributed. i) At least 2 meetings to share goals of watershed project have been held with local agricultural businesses and organizations. j) At least one workshop held for non-operator landowners.
Medium Term (3-7 years)
a) At least 4 educational workshops held. b) At least 3 meetings held with agricultural landowners. c) At least 2 municipalities/governing bodies in watershed adopt/amend current code or ordinance to match goals of watershed plan. d) At least 10 people attend each educational workshop and meeting. e) At least 4 issues of "Basin Buzz" newsletter distributed.
Long Term (7-10 years)
a) Conduct survey of agricultural landowners on watershed issues (At least 75% surveyed can identify the major source of water pollution in the watershed and methods to protect water quality). b) At least three issues of "Basin Buzz" newsletter distributed.

14.0 Literature Cited

Chen, Liming, and Warren Dick. 2011 .Gypsum as an Agricultural Amendment, General Use Guidelines. Ohio State University. Bulletin 945.

Cooley, Eric, Dennis Frame, and Aaron Wunderlin. 2010. Understanding Nutrient & Sediment Loss at Pagel's Ponderosa Dairy-Fact Sheet Series. University of Wisconsin-Discovery Farms.

Dodds, W.K., W.W. Bouska, J.L. Eitzman, T.J. Pilger, K.L. Pitts, A.J. Riley, J.T. Schoesser, and D.J. Thornbrugh. 2009. Eutrophication of U. S. freshwaters: analysis of potential economic damages. Environmental Science and Technology 43: 12-19. doi: 10.1021/es801217q

ESRI. 2016. 2012-2017 USA Population Change. Accessed July 21, 2016: https://www.arcgis.com/home/item.html?id=59ff4d5241cd46b09379cd91eb6ea18e

Gleason, R.A., Tangen, B.A., Laubhan, M.K., Kermes, K.E., and Euliss, N.H., Jr., 2007, Estimating water storage capacity of existing and potentially restorable wetland depressions in a subbasin of the Red River of the North: U.S. Geological Survey Open-File Report 2007–1159, 36 p.

Nickerson, Cynthia, Mitchell Morehart, Todd Kuethe, Jayson Beckman, Jennifer Ifft, and Ryan Williams. February 2012. Trends in U.S. Farmland Values and Ownership. EIB-92. United States Department of Agriculture, Economic Research Service.

Natural Resources Conservation Services (NRCS). March 1998. Erosion and Sediment Delivery. Field Office Technical Guide. Retrieved from: http://efotg.sc.egov.usda.gov/references/public/IA/Erosion_and_sediment_delivery.pdf

Natural Resources Conservation Services (NRCS). November 2003. Streambank Erosion. Field Office Technical Guide. Retrieved from: efotg.nrcs.usda.gov/references/public/WI/StreambankErosion.doc

Oklahoma State University. n.d. Phosphorus Removal Structures: A new best management practice to help improve water quality [brochure]. Stillwater, Oklahoma. Retrieved from http://phrog.okstate.edu/#Problem

Omernik, J.M., S.S. Chapman, R.A. Lillie, and R.T. Dumke. 2000. "Ecoregions of Wisconsin." Transactions of the Wisconsin Academy of Sciences, Arts, and Letters. 88 :77-103.

Porter, S.A., M.D. Tomer, D.E. James, and K. M.B. Boomer. 2015. Agricultural Conservation Planning Framework: ArcGIS® Toolbox User's Manual. USDA Agricultural Research Service, National Laboratory for Agriculture and the Environment, Ames Iowa. Available http://northcentralwater.org/acpf/

Sharpley, Andrew, Helen Jarvie, Anthony Buda, Linda May, Bryan Spears, and Peter Kleinman. 2013. Phosphorus Legacy: Overcoming the Effects of Past Management Practices to Mitigate Future Water Quality Impairment. J. Environ.Qual. 42. 1308-1326. doi:10.2134/jeq2013.03.0098

U.S. Census Bureau/American Fact Finder. "DP-1-Profile of General Population and Housing Characteristics: 2010." *2010 Demographic Profile Data*. U.S. Census Bureau, 2010. Accessed July 21, 2016: http://factfinder2.census.gov

U.S. Census Bureau/ American Fact Finder. "S1901-Income in the Past 12 Months." *2008-2012 American Community Survey 5-Year Estimates*. U.S. Census Bureau's American Community Survey Office, 2012. Accessed July 21, 2016: http://factfinder2.census.gov

U.S. Department of Agriculture National Agricultural Statistics Service (USDA NASS). 1999. Agricultural Economics and Land Ownership Survey. Retrieved from https://www.agcensus.usda.gov/Publications/1997/Agricultural_Economics_and_Land_Ownership/

U.S. Environmental Protection Agency (USEPA). March 2008. Handbook for Developing Watershed Plans to Restore and Protect Our Waters. EPA 841-B-08-002.

U.S. Environmental Protection Agency (USEPA). May 2006. Wetlands: Protecting Life and Property from Flooding. EPA843-F-06-001. Retrieved from: http://water.epa.gov/type/wetlands/outreach/upload/Flooding.pdf

Wisconsin Department of Natural Resources (WDNR). March 2012. Total Maximum Daily Load and Watershed Management Plan for Total Phosphorus and Total Suspended Solids in the Lower Fox River Basin and Lower Green Bay. Wisconsin Department of Natural Resources. Madison, WI

Appendix A. Glossary of Terms and Acronyms.

Animal Unit (AU) - a standard unit used in calculation of the relative grazing impact of different kinds and classes of livestock. One animal unit is defined as a 1,000 lb beef cow.

BARNY- Wisconsin adapted version of the ARS feedlot runoff model that estimates amount of phosphorus runoff from feedlots.

Baseline –An initial set of observations or data used for comparison or as a control.

Best Management Practice (BMP) – A method that has been determined to be the most effective, practical means of preventing or reducing pollution from nonpoint sources.

Cost-Sharing- Financial assistance provided to a landowner to install and/or use applicable best management practices.

Ephemeral gully- Voided areas that occur in the same location every year that are crossable with farm equipment and are often partially filled in by tillage.

Geographic Information System (GIS) – A tool that links spatial features commonly seen on maps with information from various sources ranging from demographics to pollutant sources.

Index of Biotic Integrity – An indexing procedure commonly used by academia, agencies, and groups to assess watershed condition based on the composition of a biological community in a water body.

Lateral Recession Rate- the thickness of soil eroded from a bank surface (perpendicular to the face) in an average year, given in feet per year.

Natural Resources Conservation Service (NRCS) - Provides technical expertise and conservation planning for farmers, ranchers, and forest landowners wanting to make conservation improvements to their land.

Phosphorus Index (PI) – The phosphorus index is used in nutrient management planning. It is calculated by estimating average runoff phosphorus delivery from each field to the nearest surface water in a year given the field’s soil conditions, crops, tillage, manure and fertilizer applications, and long term weather patterns. The higher the number the greater the likely hood that the field is contributing phosphorus to local water bodies.

Riparian – Relating to or located on the bank of a natural watercourse such as a river or sometimes of a lake or tidewater

Soil Nutrient Application Manager (SNAP) – Wisconsin’s nutrient management planning software.

Spreadsheet Tool for Estimating Pollutant Load (STEPL) - Model that calculates nutrient loads (Phosphorus, Nitrogen, and Biological Oxygen Demand) by land use type and aggregated by watershed.

Soil and Water Assessment Tool (SWAT) – A small watershed to river basin-scale model to simulate the quality and quantity of surface and ground water and predict the environmental impact of land use, land management practices, and climate change. Model is widely used in assessing soil erosion prevention and control, non-point source pollution control and regional management in watersheds.

Stream Power Index (SPI) – Measures the erosive power of overland flow as a function of local slope and upstream drainage area.

Total Suspended Sediment (TSS) - The organic and inorganic material suspended in the water column and greater than 0.45 micron in size.

Total Maximum Daily Load (TMDL) - A calculation of the maximum amount of pollutant that a water body can receive and still meet water quality standards.

United States Geological Survey (USGS) – Science organization that collects, monitors, analyzes, and provides scientific understanding about natural resource conditions, issues, and problems.

United States Environmental Protection Agency (USEPA) – Government agency to protect human health and the environment.

University of Wisconsin Extension (UWEX) – UW-Extension works with UW- System campuses, Wisconsin counties, tribal governments, and other public and private organizations to help address economic, social, and environmental issues.

Wisconsin Department of Natural Resources (WDNR) – State organization that works with citizens and businesses to preserve and enhance the natural resources of Wisconsin.

Waste Load Allocation- a portion of a receiving water's assimilative capacity that is allocated to one of its existing or future point sources of pollution. WLAs establish water quality based effluent limits for point source discharge facilities.

Appendix B. TMDL Pollutant Load Allocations for Apple Creek Watershed.

Table 29. TMDL Pollutant Load Allocation for Apple Creek Watershed. (Obtained from: Total Maximum Daily Load and Watershed Plan for Total Phosphorus and Total Suspended Solids in the Lower Fox River Basin and Lower Green Bay)

Sources	Total Phosphorus Load (lbs/yr)				Total Suspended Solids Load (tons/yr)			
	Baseline	Allocated	Reduction	% Reduction from Baseline	Baseline	Allocated	Reduction	% Reduction from Baseline
Agriculture	27,297	5,828	21,469	78.6%	4,725.4	2,074.8	2,650.6	56.1%
Urban (non-regulated)	2,837	2,837	-	-	443.2	443.2	-	-
Natural Background	255	255	-	-	34.2	34.2	-	-
LOAD ALLOCATION	**30,389**	**8,920**	**21,469**	**70.6%**	**5,202.9**	**2,552.3**	**2,650.6**	**50.9%**
Urban (MS4)	3,541	2,479	1,062	30.0%	705.8	423.5	282.3	40.0%
Construction	890	890	-	-	411.7	82.3	329.4	80.0%
General Permits	268	268	-	-	47.7	47.7	-	-
WWTF-Industrial	-	-	-	-	-	-	-	-
WWTF-Municipal	-	-	-	-	-	-	-	-
WASTELOAD ALLOCATION	**4,699**	**3,637**	**1,062**	**22.6%**	**1,165.2**	**553.6**	**611.7**	**52.5%**
TOTAL (WLA+LA)	**35,088**	**12,557**	**22,531**	**64.2%**	**6,368.1**	**3,105.9**	**3,262.3**	**51.2%**

Appendix C. GIS Data Sources Used for Maps/Analysis.

GIS/Data Type	Source Agency	Source Location/Metadata Link
Land Use,Land Cover, and ortho-photos	Outagamie County Planning Dept.	2010 Land Use. 2014 Ortho-photo: Available upon request to data source.
	Brown County Planning Dept.	2010 Land Use. 2014 Ortho-photo: Available upon request to data source. GIS website: http://www.co.brown.wi.us/departments/?department=85713eda4cdc
	US Dept of Agriculture (USDA)-FSA	NASS 2015 Cropland. 2015 NAIP: https://nassgeodata.gmu.edu/CropScape/ https://gdg.sc.egov.usda.gov/
Soil Types (SSURGO)	USDA-NRCS	http://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx
Elevation (LIDAR)	Outagamie County Planning Dept.	http://www.outagamie.org/index.aspx?page=158
	Brown County Planning Dept.	http://www.co.brown.wi.us/departments/?department=85713eda4cdc
Hydrography- 303(d) Impaired surface waters	WI Dept. of Natural Resources	ftp://dnrftp01.wi.gov/geodata/Impaired_Waters/
Hydrography	WI Dept. of Natural Resources (watershed boundary)	ftp://dnrftp01.wi.gov/geodata/watersheds/
	WI Dept. of Natural Resources (surface waters)	ftp://dnrftp01.wi.gov/geodata/hydro_24k/
	Brown County Planning Dept. (surface waters)	http://www.co.brown.wi.us/departments/?department=85713eda4cdc
	Outagamie County Planning Dept. (surface waters)	http://www.outagamie.org/index.aspx?page=158
Political/municipal boundaries	Brown and Outagamie County Planning Dept	Minor civil divisions (MCD) from counties. GIS layer availble on request from source.
MS4 Boundaries	City of Appleton	Available upon request from Source
	City of Kaukauna	Available upon request from Source
	Village of Little Chute	Available upon request from Source
Wetlands	WI Department of Natural Resources	Potentially Restorable Wetlands: Available upon request from source.
	Environmental Protection Agency	Potentially Restorable Wetlands: https://edg.epa.gov/data/Public/ORD/EnviroAtlas

Appendix D. STEPL Inputs & Results for Best Management Practices.

Upland Practices applied to Cropland:

A weighted Best Management Practice efficiency of 58.44 % for total phosphorus and 70.30% for total sediment was used for conservation practices applied to cropland. This assumes that a combination of practices will be applied to the majority (≈75%) of the crop fields in the watershed. Estimated implementation rates of each practice combination are shown in Table 30.

Table 30. Cropland Best Management practices reduction efficiencies.

Acres	Percent Implementation of cropland	Practice Combination	% reduction (phosphorus)	Weighted % reduction phosphorus	% reduction (sediment)	Weighted % reduction sediment
5,000	28	Cover Crop & Reduced Tillage	58.70	22.15	83.70	31.58
900	5	NMP & Reduced Tillage	60.40	4.10	75.00	5.09
1,000	6	NMP, Reduced Tillage, & Cover Crops	70.30	5.31	83.70	6.32
1,000	6	NMP & Cover Crops	51.00	3.85	15.00	1.13
3,000	17	Cover Crop & Low Disturbance Manure Injection & Reduced Tillage	70.10	15.87	78.80	17.84
1,100	6	Reduced Tillage	45.00	3.74	75.00	6.23
1,100	6	Cover Crop	32.00	2.66	15.00	1.25
150	1	Prescribed Grazing	68.00	0.77	76.00	0.86
Average Practice Efficiency			**56.94**	**58.44**	**62.78**	**70.30**

Table 31. STEPL inputs for combined cropland practices and load reductions.

1. BMPs and efficiencies for different pollutants on CROPLAND, ND=No Data					Load Reductions	
Watershed	Cropland				P Reduction	Sediment Reduction
	P	Sediment	BMPs	% Area BMP Applied	lb/year	t/year
W1	0.4383	0.52725	Combined BMPs-Calculated	75	14,513.71	1,668.84

Riparian Buffers:

In order to determine load reductions from riparian buffers in the STEPL model, the amount of land the buffers are treating is needed. A GIS hydrology analysis tool was used to determine the catchment area of each riparian buffer needed (Figure 44). A total of 1,752 acres would be treated with needed riparian buffers which is 10% of cropland and 200 acres of cropland would be taken out of production.

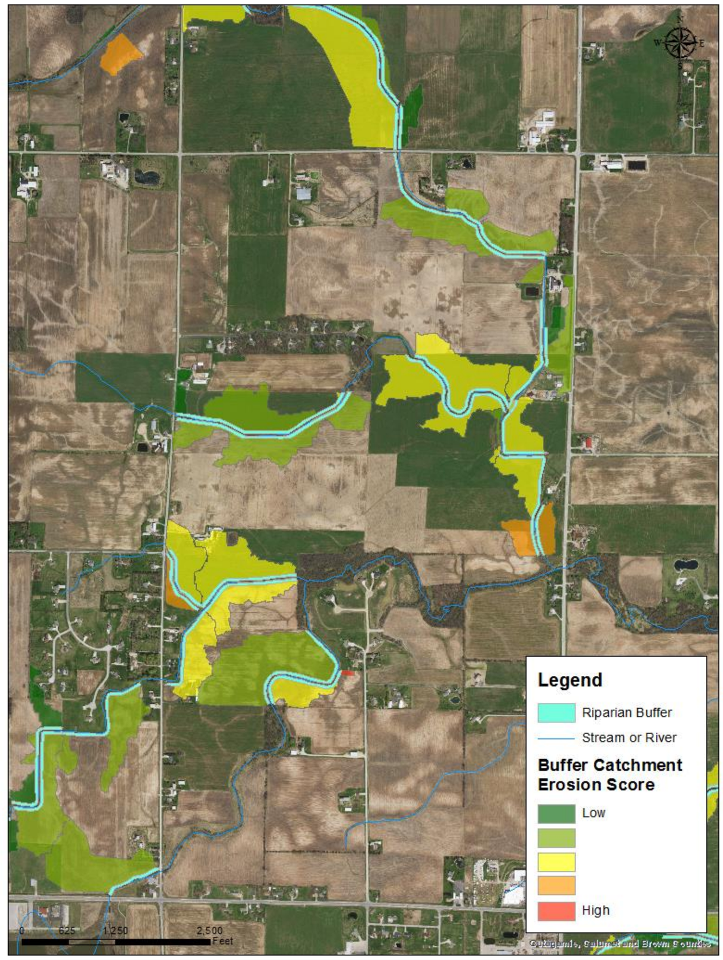

Figure 44. Riparian buffer catchment.

Table 32. STEPL inputs for Vegetative Buffers and Load Reductions.

1. BMPs and efficiencies for different pollutants on CROPLAND, ND=No Data					Load Reductions	
Watershed	Cropland				P Reduction	Sediment Reduction
	P	Sediment	BMPs	% Area BMP Applied	lb/year	t/year
W1	0.075	0.065	Filter strip	10	2357.0	182.9

Wetland Restoration:

Reductions from wetland restorations were determined assuming that 1 acre of restored wetland would be treating 20 acres of cropland. Therefore, fifteen acres of restored wetland would be treating approximately 300 acres of cropland.

Table 33. STEPL inputs and load reductions for wetland restoration.

1. BMPs and efficiencies for different pollutants on CROPLAND, ND=No Data					Load Reductions	
Watershed	Cropland				P Reduction	Sediment Reduction
	P	Sediment	BMPs	% Area BMP Applied	lb/year	t/year
W1	0.00748	0.013175	Wetland Restoration	1.7	263.77	36.42

Constructed Treatment Wetland to treat agricultural runoff/subsurface drainage:

Reductions from Constructed Treatment wetlands to treat tile drainage were determined by a assuming that one ½-1 acre size treatment wetland would treat 20 acres.

Table 34. STEPL inputs and load reductions for treatment wetlands.

1. BMPs and efficiencies for different pollutants on CROPLAND, ND=No Data					Load Reductions	
Watershed	Cropland				P Reduction	Sediment Reduction
	P	Sediment	BMPs	% Area BMP Applied	lb/year	t/year
W1	0.00154	0.0027125	Constructed Treatment Wetland	0.35	54.31	7.50

Gully/Concentrated Flow Stabilization:

Load reductions from grassed/lined waterways, WASCOBS, and concentrated flow area seedings were estimated by assuming an average height and width for gullies identified by the stream power index, windshield survey, and air photo interpretation. A total 173,325 feet of gullies and concentrated flow paths were identified in this analysis. A 70% sediment delivery ratio was applied to the load reduction with the assumption that not all sediment from eroding gullies will reach the Apple Creek.

Table 35. STEPL inputs for gully dimensions and load reductions from grassed waterways/WASCOB's.

1. Gully dimensions in the different watersheds														
Watershed	Gully	Top Width (ft)	Bottom Width (ft)	Depth (ft)	Length (ft)	Years to Form	BMP Efficiency (0-1)	Soil Textural Class	Soil Dry Weight (ton/ft3)	Nutrient Correction Factor	Annual Load (ton)	Load Reduction (ton)	Annual Load (ton)-ncf	Load Reduction (ton)-ncf
W1	Gully1	0.75	0.75	0.5	61848	1	0.95	Silt Loam	0.04	1.00	985.70	936.42	985.70	936.42

Table 36. STEPL inputs for gullies/concentrated flow and load reductions from concentrated flow area planting.

1. Gully dimensions in the different watersheds														
Watershed	Gully	Top Width (ft)	Bottom Width (ft)	Depth (ft)	Length (ft)	Years to Form	BMP Efficiency (0-1)	Soil Textural Class	Soil Dry Weight (ton/ft3)	Nutrient Correction Factor	Annual Load (ton)	Load Reduction (ton)	Annual Load (ton)-ncf	Load Reduction (ton)-ncf
W1	Gully2	0.5	0.1	0.25	85479	1	0.95	Silt Loam	0.04	1.00	272.46	258.84	272.46	258.84

Appendix E. Lower Fox River Surface Water Monitoring Summary

A summary of the WDNR Lower Fox River Surface Water Monitoring Strategy provided by Keith Marquardt (WDNR) on September 25, 2014:

Surface Water Monitoring for the Lower Fox TMDL

The primary objective for the Lower Fox River Basin monitoring project is to identify long term trends for phosphorus and suspended solids loading to the Fox River and Green Bay from major tributaries. This will provide an early warning of rising trends, and information for management issues that may arise. The principal water quality parameter of interest is total phosphorus, which is typically the limiting nutrient that affects aquatic plant growth and recreational water uses. Data collected for this project may also be used in the future to support the following objectives:

- Determining water quality standards attainment
- Identifying causes and sources of water quality impairments
- Supporting the implementation of water management programs
- Supporting the evaluation of program effectiveness

To this end, in 2013, the Wisconsin Department of Natural Resources (WDNR) convened a Lower Fox Monitoring Committee to develop and subsequently implement a surface water monitoring plan to evaluate the effectiveness of TMDL implementation in the Lower Fox River Basin. The Lower Fox River Basin comprises approximately 640 sq. miles, and, in general, extends from the outlet of Lake Winnebago to Green Bay. In general, the Basin contains 39 miles of the Fox River (referred to as the main stem) and 13 streams (referred to as tributaries) flowing into the Fox River.

The Lower Fox TMDL Monitoring Committee included representation from the University of Wisconsin Green Bay, (UWGB), the United States Geological Survey (USGS), the Oneida Nation, the WDNR, and municipal wastewater representatives.

The Committee noted that due to the size of the basin and complexity of source inputs (both point and nonpoint source pollution including urban runoff, rural runoff, and discharges) and the lack of currently available funding for surface water monitoring, that the scope of monitoring may be limited at the start. However, the current and proposed monitoring is sufficient to provide a baseline network (framework) that can be expanded upon in the future to accommodate implementation efforts occurring in the basin [for example, if conservation practices are focused in a particular sub-watershed, additional monitoring activities should accompany the implementation efforts].

Surface water monitoring in the Lower Fox was divided into two (2) components: the **Main Stem** (the Fox River itself) and the **Tributaries** (13 total).

Main Stem

The Lower Fox River Main Stem monitoring includes the weekly collection of water samples from 3 or 4 monitoring locations from roughly March through October for a total of 35 weeks. Water samples will be analyzed at the Wisconsin State Laboratory of Hygiene (or a state certified laboratory) for analysis of total suspended solids (TSS), total phosphorus (TP), dissolved P, volatile organic solids, chlorophyll A, and dissolved oxygen (D.O.) . In addition, flow data will be collected at each of the four (4) main stem locations. The four (4) monitoring locations on the Main Stem include: the Lake Winnebago outlet (Neenah – Menasha dam), the De Pere dam, the mouth of the Fox River, and a proposed location near Wrightstown bridge.

Tributaries

For the 13 streams flowing into the Fox River, surface water quality monitoring will be conducted at one location at each of the 13 tributary sites on a monthly basis from May through October 2015 (for a total of 6 monthly monitoring events at 13 locations).

On each sampling date, volunteers will collect and ship surface water samples to the Wisconsin State Laboratory of Hygiene for the analysis of TP, TSS, and dissolved reactive phosphorus (DRP). In addition, volunteers will utilize transparency tubes to assess and document the transparency of each stream on each date.

See location map.

BIOLOGICAL ASSESSMENT and Secchi

Currently, volunteers are anticipated to perform Secchi depth and conduct submergent aquatic vegetation surveys in Lower Green Bay on a periodic basis.
To assess the biological health of the streams, macroinvertebrate samples will be collected during September or October and delivered to UW-Superior for identification to lowest taxonomic level on a periodic basis, currently proposed to be every 3 to 5 years.

Other

When warranted, based on water quality results, additional monitoring may be required. The WDNR will perform monitoring for confirmation prior to delisting the impaired water segments.

All sampling will be conducted in accordance with WDNR protocol.

Appendix F. Strategy to Meet Lower Fox TMDL Phosphorus Reduction Target.

As described on pages 73-75, this plan estimates, using STEPL, a 70 % reduction in P loading(N = 18,614 lbs. P) will be achieved when a combination of practices are implemented on 75% (N = 13,250 ac) of cropland acres and reductions from other sources (e.g., barnyard retrofits, pastures) are achieved in the Apple Creek watershed. This P reduction falls short of the Lower Fox TMDL non-point agricultural P load reduction of 78.6% (N= 20,908 lbs. P). Using STEPL, the estimated amount of additional P reduction needed to meet 78.6% TMDL P reduction goal is 2,294 lbs. P.

The remaining amount of P reduction (2,294 lbs. P) will be achieved via the two measures listed below.

1. Implementation of practices described in plan on 2,085 additional cropland/pasture/hay acres (NOTE: the number of additional acres was determined from this plan's estimated 14,513.7 lbs. P reduction on 13,250 acres = 1.10 lbs./P average reduction; 2,085 acres x 1.10 lbs./P = 2,294 lbs. P).
2. Implementation of new practices or technologies (described on pages 67-75) that is either currently under development or has not yet been evaluated/measured for effectiveness.

These two measures may or may not be implemented within this plan's ten year schedule. As this plan is implemented not only will actual implemented practices and pollutant load reductions be calculated and compared to plan milestones, but new or additional practices (e.g., aerial cover crop seeding, gypsum applications, tile line outlet treatment structures) are planned for evaluation to determine feasibility and pollutant reduction efficiencies (see Table 20). Once determined, this information will be incorporated into the plan and may help meet the overall TMDL P reduction goal for this watershed. This plan contains several milestones to complete adaptive management by incorporating new information, over time. If it becomes clear from such evaluation, that the 78.6% TMDL P reduction will not be met within the plan's ten year schedule, this plan will be revised with a new schedule (and revised load reduction estimates) to include additional or new practices to achieve the Lower Fox TMDL P reduction goal.

Appendix G. EPA Potentially Restorable Wetlands on Agricultural Land.

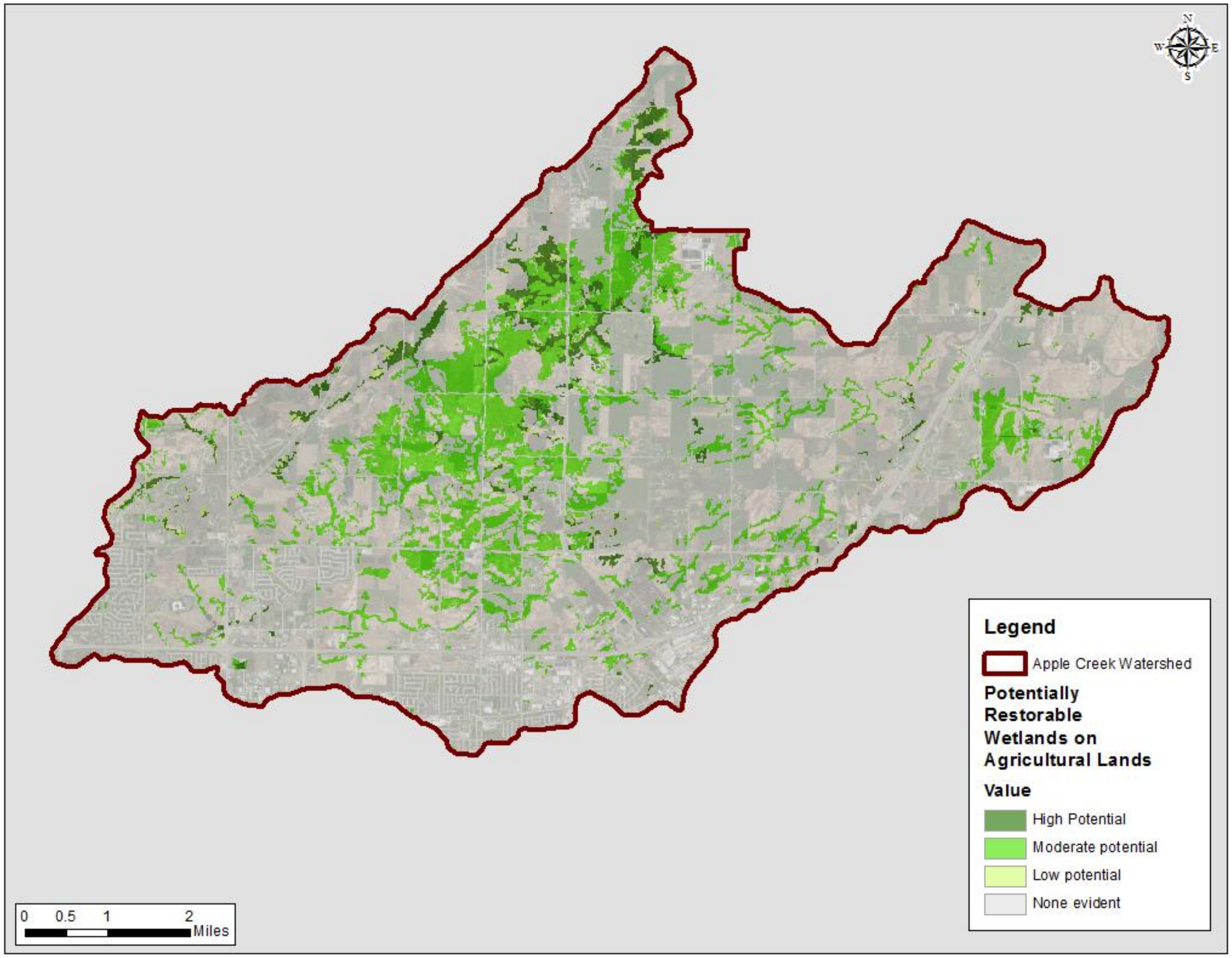

Figure 45. EPA's Potentially Restorable Wetlands on Agricultural Land. (Source: EPA EnviroAtlas)

Appendix H. SnapPlus Scenarios.

Table 37. SnapPlus scenarios comparing current conditions to no –till, residue management, and combination of no-till/residue management on select fields in Plum and Kankapot Watershed, Wisconsin.

Field Name	Acres	Soil Series & Map Symbol (Critical)	Rotation	Tillage	Report Period	Field "T" t / ac	Rot Avg Soil Loss t / ac	Rot Avg PI	Soil Test P ppm	Soil loss reduction, %	PI reduction, %
Field-1-current	35.00	KEWAUNEE(KhB2)	Csl-Csl-Csl-As-A-A-AG	FCND-FCND-FCND-FCND-None-None-None	2010-2016	3	3	3.6	35		
Field-1 cover crop with tillage	35.00	KEWAUNEE(KhB2)	CslR-CslR-CslR-As-A-A-AG	SCND-SCND-SCND-SCND-None-None-None	2010-2016	3	1.1	1.6	35	63.05%	55.56%
Field-1 no-till	35.00	KEWAUNEE(KhB2)	Csl-Csl-Csl-As-A-A-AG	NT-NT-NT-NT-None-None-None	2010-2016	3	1.4	1.9	35	52.98%	47.22%
Field-1-cover crop & no-till	35.00	KEWAUNEE(KhB2)	CslR-CslR-CslR-As-A-A-AG	NT-NT-NT-NT-None-None-None	2010-2016	3	0.4	0.9	35	85.62%	75.00%
Field 2-current	72.00	KEWAUNEE(KhB)	A-A-Csl-Csl-Csl-As-A	None-None-SCND-FVT-FVT-FVT-None	2013-2019	3	2.8	4.1	53		
Field 2 cover crop with tillage	72.00	KEWAUNEE(KhB)	A-A-CslR-CslR-CslR-As-A	None-None-SCND-SCND-SCND-SCND-None	2013-2019	3	1.4	2.3	53	51.43%	43.90%

Field Name	Acres	Soil Series & Map Symbol (Critical)	Rotation	Tillage	Report Period	Field "T" t / ac	Rot Avg Soil Loss t / ac	Rot Avg PI	Soil Test P ppm	Soil loss reduction, %	PI reduction, %
Field 2 no-till	72.00	KEWAUNEE(KhB)	A-A-Csl-Csl-Csl-As	None-None-NT-NT-NT-NT	2013-2018	3	2.4	3.2	53	13.35%	21.95%
Field 2 cover crop & no-till	72.00	KEWAUNEE(KhB)	A-A-CslR-CslR-CslR-As-A	None-None-NT-NT-NT-NT-None	2013-2019	3	0.7	1.2	53	76.29%	70.73%
Field 3-current	35.00	KEWAUNEE(KkE3)	Csl-Csl-As-A-A-A-Csl	ST-FVT-FCND-None-None-None-FVT	2013-2019	5	4.3	5.1	34		
Field 3 cover crop with tillage	35.00	KEWAUNEE(KkE3)	CslR-CslR-As-A-A-A-CslR	FCND-SCND-SCND-None-None-None-FCND	2013-2019	5	2.6	3.1	34	41.07%	39.22%
Field 3 no-till	35.00	KEWAUNEE(KkE3)	Csl-Csl-As-A-A-A-Csl	NT-NT-NT-None-None-None-NT	2013-2019	5	2.4	2.6	34	45.22%	49.02%
Field 3 cover crop & no-till	35.00	KEWAUNEE(KkE3)	CslR-CslR-As-A-A-A-CslR	NT-NT-FCND-None-None-None-NT	2013-2019	5	1.4	1.7	34	68.85%	66.67%